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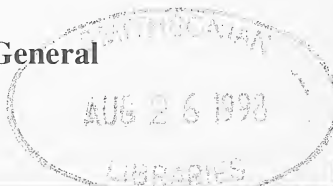
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REVIEW OF THE COSTA RICAN GLAPHYRIINAE (LEPIDOPTERA: PYRALOIDEA: CRAMBIDAE)

M. ALMA SOLIS AND DAVID ADAMSKI

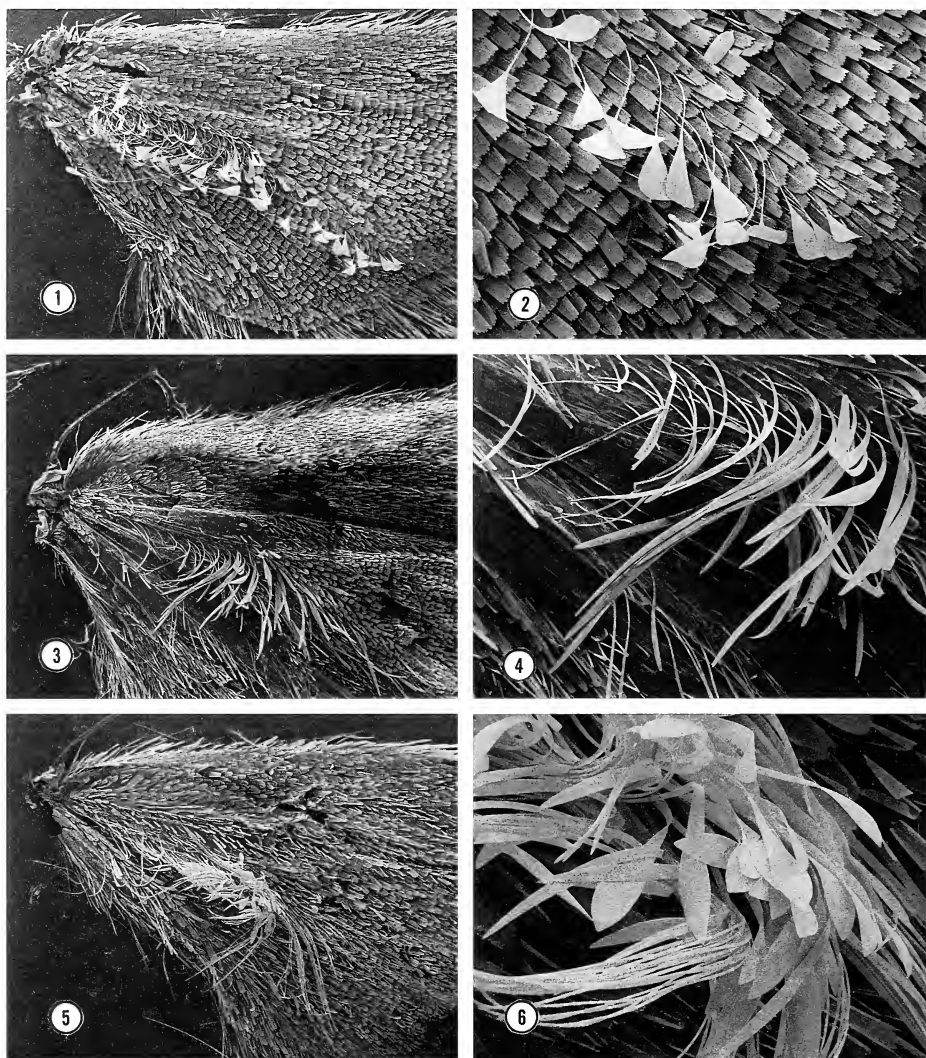
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Abstract.—Thirty-one species of Glaphyriinae (Crambidae: Pyraloidea) from Costa Rica are reviewed, including nine new species: *Aureopteryx olufsoni*, *Eupoca haakei*, *Glaphyria tetraspina*, *Glaphyria spinacrista*, *Glaphyria stellaspina*, *Glaphyria spinasingularis*, *Lipocosma rosalia*, *Lipocosma pitilla*, and *Lipocosma fonsecai*. *Lipocosma teliferalis* Dyar is a junior synonym of *Lipocosma punctissimalis* Dyar, *Lipocosma plagalis* Schaus is a junior synonym of *Lipocosma ausonialis* (Druce), and *Parambia gleanealis* Dyar is a junior synonym of *Parambia gnomosynalis* Dyar. A key to the identification of Costa Rican species is provided. The presence of a pseudognathos in the male genitalia and modified scales on the area between CuA₂ and CuP of the hind wing are discussed.

In this study of Costa Rican Glaphyriinae we review 22 described species, describe nine new species (Table 1), and provide a key for their identification. Munroe (1995) currently recognizes 161 species among 32 glaphyriine genera, and with the exception of 1 species in *Hellula* Guenée, they are New World in distribution. Munroe (1964, 1972) described 13 new genera and 32 new species from the Neotropical Region and reviewed the Nearctic species. A revision and phylogenetic analysis of the entire subfamily is greatly needed and our present study does not allow a comprehensive study. Consequently, we do not attempt to re-define the subfamily or genera within or provide evidence for the monophyly of same. See the Materials and Methods section for placement methodology within genera.

Glaphyriines have very diverse biologies and habits and their symbiotic and/or parasitic relationships with hymenopterans have attracted interest. Munroe (1972) provided a brief description of the life histories of the few known species: "the larva of *Hellula* is a leaf webber on cabbage, *Brassica oleracea* L., and other Cruciferae; that of *Dicymolomia julianalis* (Walker) lives parasitically on psychid caterpillars and apparently also in cat-tail heads (*Typha* species); that of *D. opuntialis* Dyar has been reared from prickly pear cacti (*Opuntia* species); those of *Chalcoela* species live in the nests of vespid wasps and that of *Lipocosma adelalis* (Kearfott) is a case-maker living on lichens." The biology of *Dicymolomia pegasalis* (Walker) and *Chalcoela iphitalis* Walker as parasites of *Polistes* larvae has been extensively studied and reviewed (e.g., Nelson, 1968; Rau, 1941).

Forbes (1923) first established the Glaphyriinae as part of the Pyralidae (*sensu lato*) on the basis of spatulate scales found on the upperside of the hind wing between CuA₂ and CuP. We found that the patch of specialized scales can be piliform, spatulate, or a combination of these types of scales, not just spatulate using scanning electron micrography (Figs. 1-6; Table 1). Further, Forbes (1923) stated that the spatulate scales are deciduous and visible only on fresh specimens. It is significant to note that in our study we found that some fresh specimens of neotropical species,



Figs. 1–6. 1. Hind wing of *Aureopteryx argentistriata* (Hampson). 2. Hind wing piliform scales of *Aureopteryx argentistriata* (Hampson). 3. Hind wing of *Pseudoligostigma punctissimalis* (Dyar). 4. Hind wing piliform and squamiform scales of *Pseudoligostigma punctissimalis* (Dyar). 5. Hind wing of *Lipocosma calla* (Kaye). 6. Hind wing spatulate scales of *Lipocosma calla* (Kaye).

as well as museum specimens of previously described species, lack these spatulate scales on the area between CuA_2 and CuP of the hind wing (Table 1).

Munroe (1964) followed Forbes' (1923) concept of the Glaphyriinae and expanded it by transferring genera from other pyraloid subfamilies. Munroe (1964) stated that "examination of genitalia has shown that this [the Glaphyriinae] is indeed a natural

Table 1. Costa Rican Glaphyriinae; pseudognathos present (+) or absent (-); specialized scales on hind wing present (+) or absent (-); ? = male unknown.

	Pseudognathos	Scales
<i>Aureopteryx</i> Amsel, 1956		
<i>A. argentistriata</i> (Hampson, 1917)	+	+
<i>A. olufsoni</i> Solis and Adamski, n.sp.	+	-
<i>Chilozela</i> Munroe, 1964		
<i>C. trapeziana</i> (Sepp, [1840])	-	-
<i>Cosmopterosis</i> Amsel, 1956		
<i>C. theytysalis</i> (Walker, 1859)	+	+
<i>Dicymolomia</i> Zeller, 1872		
<i>D. metalophota</i> (Hampson, 1897)	-	+
<i>Eupoca</i> Warren, 1891		
<i>E. bifascialis</i> (Walker, 1863)	-	-
<i>E. chicalis</i> (Schaus, 1920)	-	-
<i>E. haakei</i> Solis and Adamski, n.sp.	?	-
<i>E. sanctalis</i> (Schaus, 1912)	-	-
<i>Glaphyria</i> Hübner, 1823		
<i>G. citronalis</i> (Druce, 1899)	?	-
<i>G. decisa</i> (Walker, [1866])	-	+/-
<i>G. rufescens</i> (Hampson, 1912)	?	+
<i>G. spinacrista</i> Solis and Adamski, n.sp.	?	+
<i>G. spinasingularis</i> Solis and Adamski, n.sp.	-	+/-
<i>G. stellaspina</i> Solis and Adamski, n.sp.	+	+/-
<i>G. tetraspina</i> Solis and Adamski, n.sp.	+	-
<i>Hellula</i> Guenée, 1854		
<i>H. phidilealis</i> (Walker, 1859)	-	-
<i>Homophysodes</i> Dyar, 1914		
<i>H. morbidalis</i> (Dyar, 1914)	-	+
<i>Lipocosma</i> Lederer, 1863		
<i>L. albibasalis</i> (Hampson, 1906)	-	+
<i>L. ausonialis</i> (Druce, 1899)	+	+
<i>L. calla</i> (Kaye, 1901)	+	+
<i>L. fonsecai</i> Solis and Adamski, n.sp.	+	+
<i>L. furvalis</i> (Hampson, 1912)	+	-
<i>L. nigripictalis</i> Hampson, 1898	+	+
<i>L. pitilla</i> Solis and Adamski, n.sp.	+	-
<i>L. rosalia</i> Solis and Adamski, n.sp.	+	+
<i>Parambia</i> Dyar, 1914		
<i>P. gnomosynalis</i> Dyar, 1914	-	+
<i>Pseudoligostigma</i> Strand, 1920		
<i>P. argyractalis</i> (Schaus, 1912)	?	+
<i>P. enarereralis</i> (Dyar, 1914)	?	+
<i>P. punctissimalis</i> (Dyar, 1914)	-	+
<i>Stegea</i> Munroe, 1964		
<i>S. hermalis</i> (Schaus, 1920)	+	+/-

and compact group . . . ,” but he did not elaborate on which characters define the subfamily. Recently, Munroe and Solis (in press) described the subfamily, summarized as follows: head (Fig. 7) with a three-segmented labial palpus, ocellus present, chaetosema absent; tympanic organ (Fig. 8) with praecinctorium simple; the wing venation and pattern as shown (Figs. 9–11), frenulum hook present in males, frenulum single in male, multiple in females; male genitalia (Figs. 12–25) with uncus well developed, gnathos reduced or absent; female genitalia (Figs. 26–35) with sclerotized collar, sometimes with additional armature. A major correction applies to this diagnosis of the Glaphyriinae with regard to the gnathos. The gnathos in the Glaphyriinae is absent; it is the pseudognathos in the Glaphyriinae that is present or absent. The pseudognathos are “structures arising from the lateral margin of the tegumen” and they may be “separate or medially fused” (Maes, 1998). When present the pseudognathos can be small lateral projections of the tegumen (as in *L. rosalia* or *A. olufsoni*) to highly modified structures fused medially with a medial projection (as in *L. fonsecai*). A phylogenetic study of the entire Glaphyriinae would elucidate the evolution of this variable structure within and between genera.

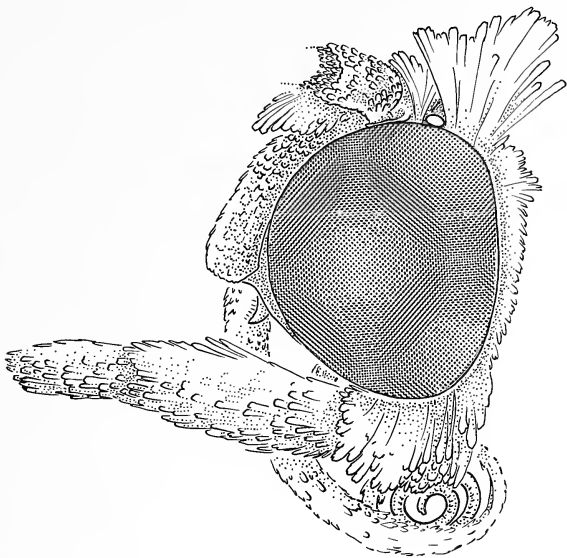
Glaphyriinae can be identified as members of the Crambidae because they have a praecinctorium (Fig. 8) and can be distinguished from the Pyralidae that lack a praecinctorium. Glaphyriines are mostly small white, yellow, brown moths (wing length generally less than 9 mm, except for *Chilozela*) and many species can be identified by the specialized scales on the area between CuA_2 and CuP of the hind wing that occur in no other subfamilies as far as known. Those species that lack these specialized scales can be confused with members of the Pyraustinae. They can be distinguished from most Pyraustinae because their praecinctorium is bilobed, and the glaphyriines have a praecinctorium with no lobes.

MATERIALS AND METHODS

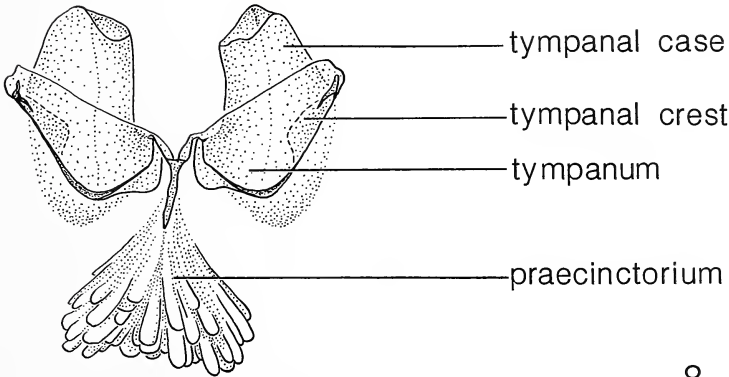
In an effort to identify those taxa with taxonomic and nomenclatural problems, we conducted a preliminary survey of pyraloids in the extensive Costa Rican collection (now incorporated into the Instituto Nacional de Biodiversidad (INBio)) of D. Janzen and W. Hallwachs. Field collection of the Pyraloidea throughout Costa Rica was accomplished by INBio parataxonomists as part of an on-going project to inventory the Pyraloidea fauna in that country.

Pinned specimens were examined with an incandescent light source (reflected light). Colors of the vestiture were described using *The Methuen Handbook of Colour* (Kornerup and Wanscher, 1983) as a standard. Male and female genital dissections were prepared following Clarke (1941), using chlorazol black and Mercurochrome as staining agents. Wings were prepared by staining with Eosin-Y and slide mounted in Canada balsam. All measurements were made with the aid of an ocular micrometer. Fore wing length is measured from the center of the axillary area to the apex of the fore wing. The label data are transcribed as on the label, the Costa Rican locality is represented by the Lambert Coordinate System (L-N or L-S) when indicated, followed by the collector(s), the INBio acronym, and the bar code number given to each specimen.

The preliminary composition of the neotropical Glaphyriinae was based on the checklist by Munroe (1995). Costa Rican specimens were dissected to identify di-



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Figs. 7–8. 7. Stylized glaphyriine head. 8. Tympanic organ of *Eupoca chicalis* Schaus.

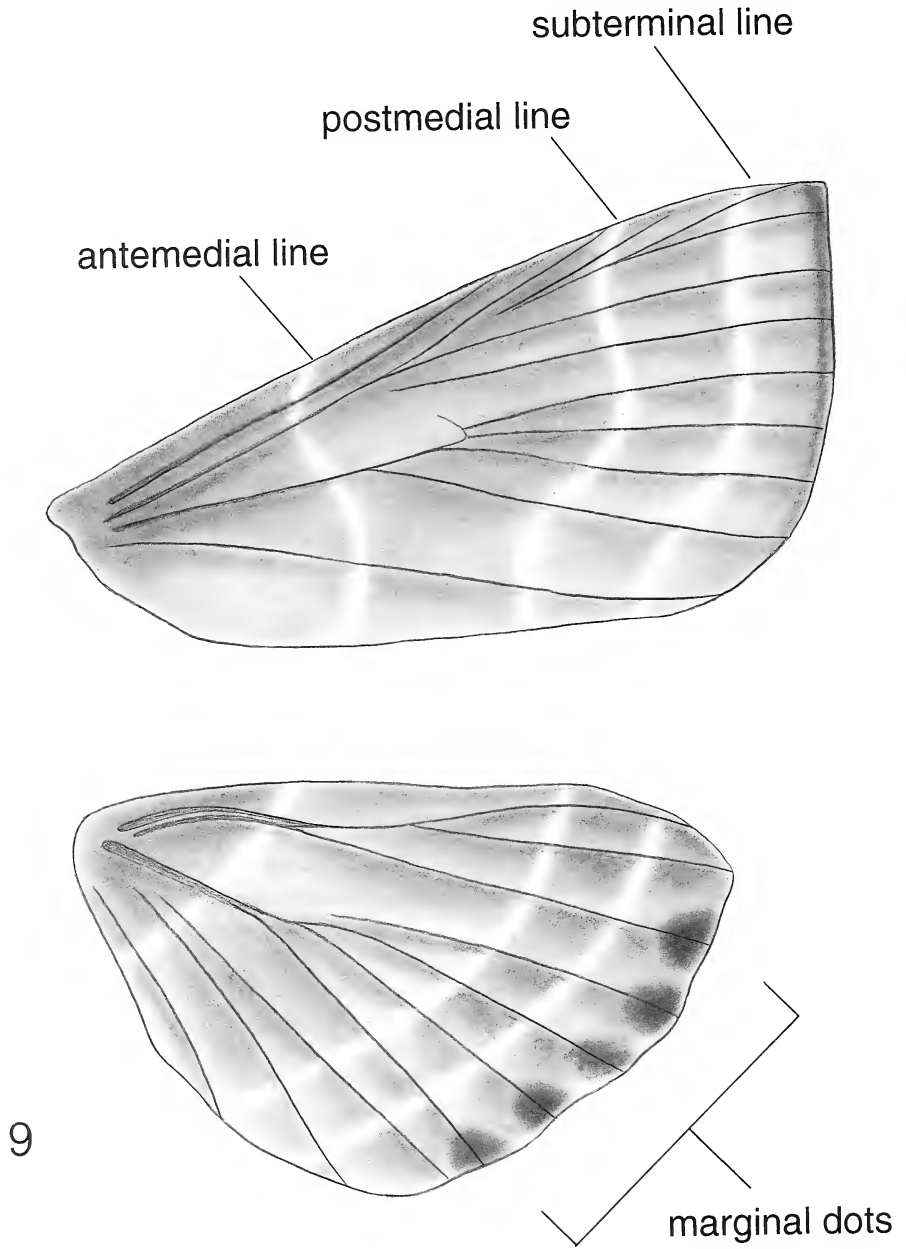
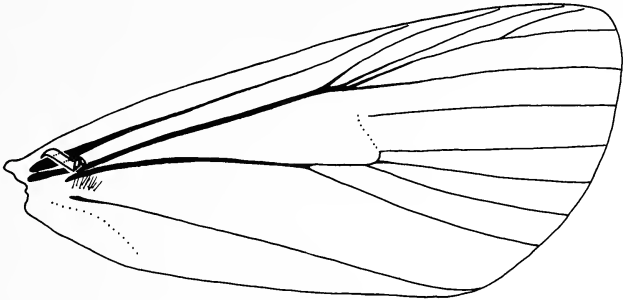
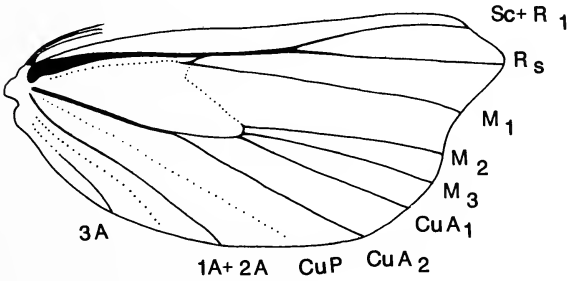
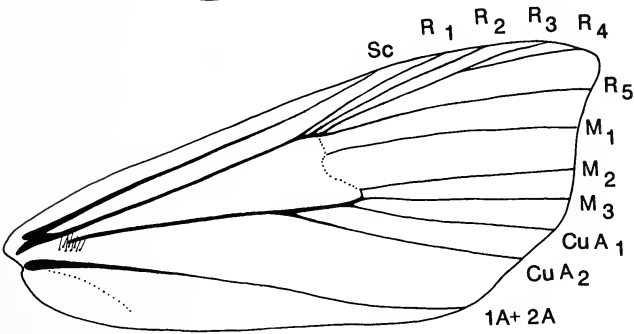
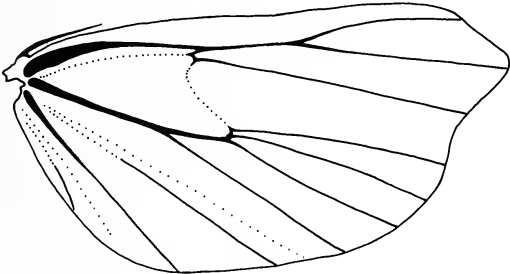


Fig. 9. Stylized glaphyriine wing pattern.



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11

Figs. 10–11. 10. Male wing venation of *Lipocosma rosalia* Solis & Adamski. 11. Female wing venation of *Lipocosma rosalia* Solis & Adamski.

agnostic characters for each species because the genital characters of many Central American glaphyriine species are unexplored. Species level characters are unique to Glaphyriinae species, especially the female characters, and these are listed in the diagnosis. Because we do not attempt to re-define the genera, the placement of a new species in a genus was accomplished by comparison with type species and previous works (i.e., Munroe 1964, 1972). To determine the identity and nomenclatural status of Costa Rican species, types of neotropical species at the The Natural History Museum (BMNH), London, England, and at the National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C. were examined and dissected if external morphology was similar to Costa Rican species. The holotypes of new species are deposited in the Instituto Nacional de Biodiversidad, San Jose, Costa Rica (INBio), and paratypes are deposited in the USNM. The general distribution for each species is based on the USNM Glaphyriinae collection, the largest and most representative collection in the world.

KEY TO THE GLAPHYRIINAE OF COSTA RICA BASED ON EXTERNAL MORPHOLOGY OF THE ADULTS

- 1 In both sexes, hind wing between CuA_2 and CuP with broadly arched piliform or spatulate (very long base with a spatulate apex) scales or a combination of scales (Figs. 1–6) 2
- Hind wing between CuA_2 and CuP without such scales. 21
- 2(1) Hind wing between CuA_2 and CuP with a combination of piliform scales intermixed with spatulate scales (Figs. 3, 55) . . . *Pseudoligostigma punctissimalis* (Dyar)
- Hind wing between CuA_2 and CuP with linear cluster of either piliform or spatulate scales (Figs. 2, 6) 3
- 3(2) Hind wing between CuA_2 and CuP with piliform scales only (Fig. 2) 4
- Hind wing between CuA_2 and CuP with spatulate scales only (Fig. 6) 10
- 4(3) Hind wing without marginal spots 5
- Hind wing with marginal spots 6
- 5(4) Fore wing falcate; hind wing with subcircular brown spot near middle of discal cell (Fig. 61) *Lipocosma fonsecai* Solis & Adamski
- Fore wing round; hind wing without spot near middle of discal cell (Fig. 50) *Glaphyria stellaspina* Solis & Adamski
- 6(4) Hind wing with marginal spots between Rs and CuA_2 or M_1 and CuA_2 (Fig. 39) *Cosmopterosis thetysalis* (Walker)
- Hind wing with marginal spots between M_2 and CuP or M_2 and $1A+2A$ 7
- 7(6) Hind wing with six pairs of marginal spots oriented longitudinally or four marginal spots between M_2 and CuP 8
- Hind wing with seven marginal spots between M_2 and $1A+2A$ 9
- 8(7) Hind wing with six pairs of marginal spots, each pair oriented longitudinally; fore wing with four silver streaks from middle of wing to near subterminal line and between costa and M_3 (Fig. 36) *Aureopteryx argentistriata* (Hampson)
- Hind wing with four marginal spots between M_2 and CuP ; fore wing without streaks (Fig. 40) *Dicynolomia metalophota* (Hampson)
- 9(8) Fore wing with white or pale-brown subterminal lines (Fig. 54) *Pseudoligostigma enareralis* (Dyar)
- Fore wing with subterminal lines suffused (Fig. 53) *Pseudoligostigma argyractalis* (Schaus)
- 10(3) Fore wing pattern with white scales 11

– Fore wing pattern with yellow scales 13

11(10) Fore wing basal fascia pattern with brown and white scales (Fig. 57)
..... *Lipocosma albibasalis* (Hampson)

– Fore wing basal fascia unicolorous white 12

12(11) Rest of fore wing pale brownish-orange, lines pale brown, incomplete or absent;
small brown spot in tornal area; hind wing with small spot near wing margin in
anal area, subterminal line brown (Fig. 63) *Lipocosma nigripictalis* Hampson

– Rest of fore wing mostly brown, lines concolorous; no spot in tornal area; hind
wing without spot near wing margin in anal area, subterminal line white (Fig. 66)
..... *Parambia gnomosynalis* Dyar

13(11) Fore wing medial fascia not brown 14

– Fore wing medial fascia brown 16

14(13) Fore wing basal fascia completely yellow (Fig. 60) *Lipocosma calla* (Kaye)

– Fore wing basal fascia with mixed white and yellow scales 15

15(14) Fore wing basal fascia with mixed white and golden-yellow scales; discal spot
mostly with brown scales (Fig. 65) *Lipocosma rosalia* Solis & Adamski

– Fore wing basal fascia with scales white basally and yellow distally; discal spot
with mostly yellow and white scales and very few brown scales (Fig. 59)
..... *Lipocosma ausonialis* (Druce)

16(13) Fore wing with two or three white apical streaks (Fig. 56)
..... *Homophysodes morbidalis* Dyar

– Fore wing without white apical streaks 17

17(16) Fore wing tornal area yellow (Fig. 46) *Glaphyria decisa* (Walker)

– Fore wing tornal area brown 18

18(17) Fore wing brown except costa and remaining wing areas pale brown and/or yellow
(Fig. 49) *Glaphyria spinasingularis* Solis & Adamski

– Fore wing with costa and remaining wing areas brown 19

19(18) Adterminal line a series of dark brown dots (Fig. 47).
..... *Glaphyria rufescens* (Hampson)

– Adterminal line a series of dark brown dashes 20

20(19) Fore wing ground color pale brown; lines dark brown, postmedial line delineated
by white distally, antemedial line delineated by white proximally; spatulate scales
between CuA₂ and CuP brown only at tip of spatulate area (Fig. 48)
..... *Glaphyria spinacrista* Solis & Adamski

– Fore wing ground color dark brown; lines faint, spatulate scales between CuA₂ and
CuP with spatulate area entirely brown (Fig. 67) *Stegia hermalis* (Schaus)

21(1) Hind wing with four black marginal spots between M₃ and 1A+2A (Fig. 37) ...
..... *Aureopteryx olufsoni* Solis & Adamski

– Hind wing without marginal spots 22

22(21) Upper surface of fore wing veins delineated by pale brown or white scales 23

– Upper surface of fore wing veins not delineated by contrastingly pigmented scales
..... 24

23(22) Upper surface of fore wing veins delineated by white scales, except anal vein
portion distal to subterminal line (Fig. 42) *Eupoca chicalis* (Schaus)

– Upper surface of fore wing veins delineated by pale brown scales, including portion
of anal veins distal to subterminal line (Fig. 43) .. *Eupoca haakei* Solis & Adamski

24(22) Fore wing ground color brownish-orange 25

– Fore wing with ground color brown or white 28

25(24) Fore wing length greater than 11 mm; basal, antemedial, and postmedial lines
subparallel; anterior portion of outer margin of fore wing slightly emarginate (Fig.
38) *Chilozela trapeziana* (Sepp)

- Fore wing length less than 8 mm; basal, antemedial, and postmedial lines parallel; anterior portion of outer margin of fore wing not emarginate 26
- 26(25) Fore wing with small brown spot in tornal area; wing with small spot near wing margin in anal area (Fig. 62) *Lipocosma furvalis* (Hampson)
- Without small brown spot in tornal area of fore wing or near hind wing margin in anal area 27
- 27(26) Fore wing basal fascia white, except costa with two yellow streaks; antemedial and postmedial lines brownish-orange white (Fig. 50)
..... *Glaphyria stellaspina* Solis & Adamski
- Fore wing basal fascia brownish-orange without streaks, antemedial and postmedial lines white (Fig. 51) *Glaphyria tetraspina* Solis & Adamski
- 28(24) Fore wing with ground color white; a small brown spot near costa between subterminal and postmedial lines (Fig. 64) *Lipocosma pitilla* Solis & Adamski
- Fore wing with ground color brown; no small brown spot near costa between subterminal and postmedial lines 29
- 29(28) Fore wing with medial fascia brown, except costa and other wing areas mostly yellow or white 30
- Entire fore wing mostly brown 31
- 30(29) Fore wing costa and other wing areas mostly yellow (Fig. 46)
..... *Glaphyria decisa* (Walker)
- Fore wing costa and other wing areas mostly white (Fig. 49)
..... *Glaphyria spinasingularis* Solis & Adamski
- 31(29) Fore wing grayish-brown with a crescent-shaped spot near distal end of discal cell (Fig. 52) *Hellula phidilealis* (Walker)
- Fore wing not light or dark brown, without spot near discal cell 32
- 32(31) Fore wing with four small transverse yellow apical streaks (Fig. 45)
..... *Glaphyria citronalis* (Druce)
- Fore wing without apical streaks 33
- 33(32) Fore wing antemedial and postmedial lines faint; hind wing darker brown than fore wing (Fig. 67) *Stegea hermalis* (Schaus)
- Fore wing antemedial and postmedial lines white; hind wing mostly white except subterminal line dark brown. 34
- 34(33) Fore wing with all fasciae dark brown near costa, except basal fascia light brown distally, all lines straight (Fig. 41) *Eupoca bifascialis* (Walker)
- Fore wing with apical, subapical, and tornal areas brown, basal fascia mostly light brown, all lines jagged (Fig. 44) *Eupoca sanctalis* (Schaus)

Aureopteryx Amsel

This genus includes 4 species (Munroe, 1995) and 2 occur in Costa Rica, *A. argentistriata* and a new species, *A. olufsoni*. The type species is *A. calistoalis* (Walker) described from Brazil. The placement of *Aureopteryx olufsoni* Solis and Adamski is tenuous. *Aureopteryx* species share similar wing color patterns (predominantly yellow with various metallic markings, mainly between the apical area and antemedial line of the fore wing, and metallic markings associated with marginal spots of the hind wing). The gnathos is absent, but generally the genitalia vary markedly (Figs. 12–13, 26). The male uncus may be long and basally narrow, or short and basally wide, and the valvae may be fused basally or free. The female antrum is sclerotized or membranous, the seventh sternum greatly modified or simple, the ductus bursae with or without sclerotized processes, and the signa present or absent.

These characters must be subjected to a rigorous phylogenetic analysis to determine their usefulness at the generic level.

Aureopteryx argentistriata (Hampson)

Figs. 1–2, 36

Ambia argentistriata Hampson, 1917:464.

Aureopteryx argentistriata, Munroe, 1995:44. NEW COMBINATION.

Diagnosis. Fore wing with yellow ground color and deep yellow medial and post-medial lines, subterminal line silver; four silver streaks from mid wing to near subterminal line, between costa and M_3 . Hind wing with linear cluster of dark brown piliform scales between CuA_2 and CuP , six pairs of marginal spots (each pair orientated longitudinally) between M_3 and CuA_2 . Male genitalia with uncus narrow, about half the length of valva; costa with apex produced into a single short spine. Female genitalia with signa paired, each with a forked apex.

Type. Holotype, ♂, Jimenez, W. Colombia (BMNH).

Material examined. Holotype not dissected. Other specimens examined: MEXICO: 1 ♂, El Salto. COSTA RICA: 4 ♂♂, 2 ♀♀, Est. Queb. Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, COSTA RICA, Zuniga, Ago 1990, L-N-194500-469850, COSTA RICA: INBIO: Aug. 1990-CRI18124, genitalia slide USNM 107,931, COSTA RICA: INBIO: Oct. 1989-CRI196868, Apr. 1991-CRI315596, Jun. 1991-CRI345692, Jun. 1991-CRI345695, Aug. 1989-CRI109586, Jun. 1991-CRI345697. 1 ♂, Estac. Quebrada Bonita, Prov. Puntarenas, 9/1/89-9/30/89, R. Zuniga, L-N-194500-469850, COSTA RICA: INBIO: CRI1065082. 1 ♀, Est. Sirena, 0-100m, Prov. Puntarenas, P.N. Corcovado, Oct. 91, G. Fonseca, L-S-270500-508300, COSTA RICA: INBIO: CRI348028. FRENCH GUIANA: 1 ♂, Cayenne. VENEZUELA: 1 ♀, "Fernald Coll."; 2 ♂♂, Brianas; 1 ♀, Guarico; 7 ♂♂, San Esteban. COLOMBIA: 1 ♂, Valle Palmira. PARAGUAY: 5 ♂♂, Dept. Nueva Asuncion; 1 ♂, Dept. Chaco; 2 ♂♂, Pouillon. BRAZIL: 1 ♂, Buito Prov. TRINIDAD: 1 ♀.

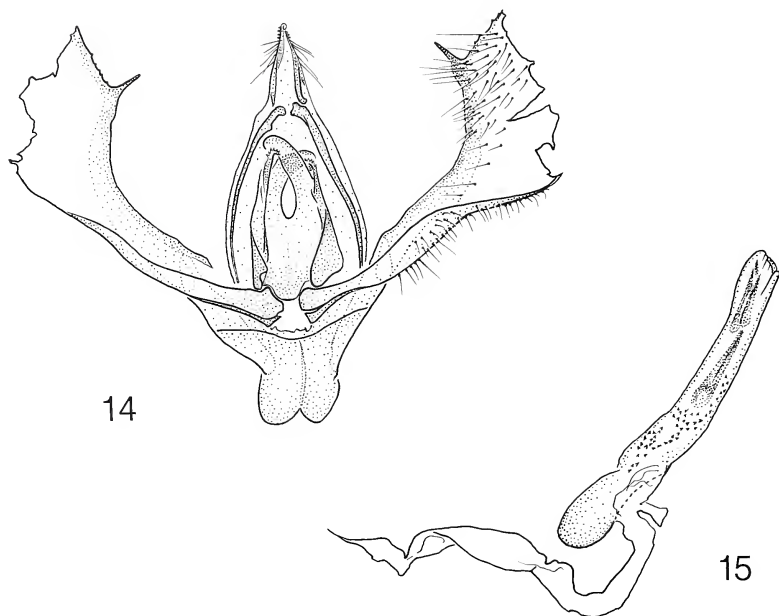
Distribution. Central Mexico south to Paraguay and Brazil, including Trinidad. In Costa Rica it is found in the lowland, Pacific areas.

Aureopteryx olufsoni, new species

Figs. 12–13, 26, 37

Diagnosis. Fore wing pale yellow with pale brown subterminal line and deep yellow antemedial line; three silver apical streaks present (partially present or absent on rubbed specimens); subterminal line on fore wing and hind wing irregular; hind wing similarly patterned as fore wing except with four small black marginal spots between M_3 and $1A+2A$. Male genitalia with valvae fused basally, costa apically flattened and inwardly curved. Aedeagus slender with cornutus several small spines. Female with anterior margin of seventh sternum deeply emarginate and with recurved anterolateral arms, signum absent.

Description. Head: Vertex and frontoclypeus mostly pale yellow intermixed with white scales (many scales are missing [rubbed] on frontoclypeus); antennal scales pale yellow basally, pale brown distally. Ocellus absent. Maxillary palpus white. Outer surface of labial palpus mostly white, except pale yellow on apical third to half of terminal segments, inner surface white. Proboscis with basal white scales.



Figs. 12–15. 12. Male genitalia of *Aureopteryx olufsoni* Solis & Adamski, USNM #103,728. 13. Aedeagus of *Aureopteryx olufsoni* Solis & Adamski, USNM #103,728. 14. Male genitalia of *Glaphyria spinasingularis* Solis & Adamski, distal end of valvae damaged, USNM #107,933. 15. Aedeagus of *Glaphyria spinasingularis* Solis & Adamski, distal end of valvae damaged, USNM #107,933.

Thorax: Tegula and mesonotum mostly white intermixed with pale yellow scales. Prothoracic leg white, except pale yellow scales on basal portion of tibia and proximal tarsomeres; apical tarsomeres, and in some specimens apical and subapical tarsomeres brown. Meso- and metathoracic legs patterned similarly as prothoracic leg. Fore wing length = 5.5–6.7 mm (N = 6). Ground color pale yellow. Three silver streaks within yellow apical area (not present or partially present on rubbed specimens). Subterminal and interneural dots brown. Brown scales demarcate discal cell radius and extend slightly beyond between R_{3+4} and R_5 . A small brown dot present near distal end of discal cell. Antemedial and basal lines yellow, both terminating near radius of discal cell. Marginal line silver, fringe scales yellow intermixed with yellowish-brown scales. Under surface mostly pale yellow, in some specimens interneural dots and anterior portion of antemedial line present. Hind wing pale yellow, subterminal line pale brown. Four marginal dots present between M_3 and $1A+2A$. Under surface pale yellow, some specimens with marginal dots with adjacent dark brown fringe scales. Area between CuA_2 and CuP without piliform or spatulate scales. Fringe scales pale yellow intermixed with yellowish-brown scales, dark brown near marginal dots.

Abdomen: Anterior portion of terga pale yellow, posterior portion white; under surface white.

Male genitalia: Uncus widened basally and hooked apically. Juxtal arms formed around aedeagus. Pseudognathos with two short lateral arms. Costa of valva apically flattened and inwardly curved. Aedeagus narrow with cornutus several small spines.

Female genitalia: Seventh tergum extended ventrally, overlapping a membranous longitudinal depression, lateral to ostium bursae. Posterior margin of seventh sternum deeply emarginate medially and with recurved anterolateral arms. Two pocketlike folds anterolateral to seventh sternum. Ostial area and ductus bursae sclerotized to near corpus bursae. Two small spinose areas within ductus bursae near inception of corpus bursae. A small fold located about equidistant to ostium bursae and eighth segment. Ductus seminalis posterior to seventh sternum.

Types. Holotype: ♀, 9.4km W.[est] Bribri, Suretka, Limon Prov.[incia] COSTA RICA, 9–11 Jun[e] 1983, 200m, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115270 [not dissected] (INBIO). Paratypes: 1 ♀, same data as holotype except, COSTA RICA: INBIO: CRI1115245, genitalia slide USNM 103,729 [green label]. 1 ♂, Sirena Corcovado Nat.[ional] P[ar]k, Osa Penin.[sula], COSTA RICA 5–11 Jan.[uary] 1981, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115246, genitalia slide USNM 103,728 [green label]. 1 ♂, Sirena, Corcovado N.[ational] P[ar]k, Puntarenas Prov.[incia], COSTA, RICA 0–100m, R. Blanco & G. Fonseca, April 1989, 270500, 508300, COSTA RICA: INBIO: CRI1103091. 1 ♂, Est.[acion] Sirena, P.N. Corcovado, 0–100m, Prov.[incia] Punt.[arenas], COSTA RICA, G. Fonseca, Oct[ober] 1990, L-S-270500, 508300, COSTA RICA: INBIO: CRI179036. 1 ♂, Estac. Quebrada Bonita, 50m R.B. Carara Puntarenas Pr.[ovincia], COSTA RICA, Se[p]t[ember] 1989, R. Zuniga, 194500, 469850, COSTA RICA: INBIO: CRI1103075. 1 ♂, Est. Sirena, P.N. Corcovado, 0–100m, Prov. Puntarenas, COSTA RICA, G. Fonseca, Mar. 1991, L-S-270500-508300, COSTA RICA: INBIO: CRI447684, genitalia slide USNM 108,079 [green label].

Distribution. The southern Atlantic and Pacific lowlands of Costa Rica.

Etymology. This species is named in honor of Curtis Olufson of Texas for his support in the development of the INBio.

Chilozela Munroe

This genus is monotypic and is externally very similar to *Chilomima* Amsel, another monotypic genus with a similar distribution and food plant. The only species of *Chilozela* has been reared from the leaves of *Manihot esculenta* Crantz known as yuca or cassava (Becker, 1986; see for further host plant citations).

Chilozela trapeziana (Sepp)

Fig. 38

Phalaena (*Tortrix*) *trapeziana* Sepp [1840]:131; Becker, 1986:196. NEW COMBINATION.

Botys jatrophalis Walker, 1859:990; Becker, 1986:196. NEW SYNONYMY [Unnecessary replacement name].

Phlyctaenodes bifilalis Hampson, 1913:518. Becker, 1986:196. NEW SYNONYMY.

Diagnosis. Basal portion of frontoclypeus protracted anteriorly. Fore wing ground color brownish-orange. Costal area and fringe scales grayish-brown. All wing lines brown. Basal, antemedial, and postmedial lines subparallel, subterminal line jagged. Anterior portion of outer margin of fore wing slightly emarginate. Hind wing without piliform or spatulate scales between CuA_2 and CuP . Fringe scales of hind wing pale brown, except grayish-brown between CuA_1 and CuA_2 . Male genitalia with outer margin of valva broadly rounded, nearly semicircular. Vesica without cornutus. Female genitalia with anterior portion of ductus bursae laterally sclerotized. Corpus bursae usually with two subequal spinose patches. Smaller patch anterior to the larger patch, the former absent in some specimens.

Types. *P. bifilalis* Hampson, lectotype, ♂, Guyana (BMNH). The type specimen of *Phalaena trapeziana* Sepp is presumed lost, however, the identity of this species can be verified by examination of the color plate that accompanies the original description (Becker, 1986).

Material examined. Types not dissected. COSTA RICA: 1 ♂, Esperanza. 1 ♂, Sixola River; PANAMA: 1 ♂, Corozal; VENEZUELA: 1 ♂, Aroa; PERU: 2♂♂, Callao. 1 ♂, 1 ♀, "Peru"; GUYANA: 1 ♀, Kartabo (Bartica District); FRENCH GUIANA: 1 ♂, 1 ♀, St. Laurent du Maroni; SURINAM: 1 ♂, 1 ♀.

Distribution. Costa Rica south to Peru.

Cosmopterosis Amsel

A monotypic genus. No biological information is available.

Cosmopterosis thetysalis (Walker, 1859)

Fig. 39

Cataclysta thetysalis Walker, 1859:440; Amsel, 1956:110. NEW COMBINATION.

Diagnosis. Apical and tornal areas of fore wing brown, a subquadrate yellow spot

from costa to middle of wing and basal to subterminal line; subterminal line silver. Hind wing with a sparse linear patch of mostly white piliform scales intermixed with brown scales between CuA_2 and CuP ; five large marginal spots between R_s and CuA_2 or M_1 and CuA_2 . Male genitalia with uncus heavily sclerotized, with two featherlike apical setae; pseudognathos toothed dorsally; sclerotized juxtal arms spinose, each with a circular spinose patch posterolaterally; aedeagus spinose posterolaterally; sacculus spinose and recurved ventrally. Female genitalia with posterior portion of female antrum as wide as seventh sternum; corpus bursae with two elliptical signa.

Type. Holotype, ♂, Villa Nova [Brazil] (BMNH).

Material examined. Holotype not dissected. Other material examined: MEXICO: 5 ♂♂, 7 ♀♀, Sinaloa. 1 ♀, Magdalena Island; COSTA RICA: 5 ♂♂, 5 ♀♀, Est. Cacao, 1000–1400m, Lado SO Vol. Cacao, P.N. Guan., Prov. Guanacaste, L-N-323300-375700, C. Chaves-Sept. 1991-COSTA RICA: INBIO: CRI356851, CRI356852, CRI356853, CRI356854, CRI356855, CRI356824, CRI356826, CRI356842, CRI356903, 8–12 Oct. CRI350093. 4 ♂♂, same data as above except: D. Garcia-11 Sept.–11 Oct. 1991-COSTA RICA: INBIO: CRI349572, CRI349573, CRI349574, CRI349581. 1 ♀, same data as above except: R. Blanco-Sept. 1989-COSTA RICA: INBIO: CRI87622. 1 ♂, same data as above except: R. Blanco & C. Chaves-Sept. 1989-COSTA RICA: INBIO: CRI87645. 1 ♀, Est. Murcielago, 8km suroeste de Cuajiniquil, 100m, Prov. Guanacaste, L-N-320300-347200, I Curso Microlepidoptera-Jul. 1990-COSTA RICA: INBIO: CRI226510. 1 ♀, Est. Pitilla, 700m, 9 km S Sta. Cecilia, P.N. Guanacaste, Prov. Guanacaste, L-N-330200-380200, C. Moraga-7/15/92/ (1:00), COSTA RICA: INBIO: CRI381748. 4 ♂♂, 4 ♀♀, Est. Queb. Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Jun. 1991-COSTA RICA: INBIO: CRI345657, CRI345554, CRI345646, CRI345648, May 1990-CRI194583, Oct. 1989-CRI127283, Aug. 1989-CRI109623, Nov. 1989-CRI139469. 5 ♂♂, 1 ♀♀, Est. Sta. Rosa, 300m, P.N. Sta. Rosa, Prov. Guanacaste, L-N-313000-359800, I Curso Microlepidoptera-Jul. 1990-COSTA RICA: INBIO: CRI224096, CRI224081, CRI224082, CRI224092, CRI224097, CRI224254. 1 ♂, Estac. Pitilla, Prov. Guanacaste, L-N-330200-380200, C. Moraga & P. Rios, 9/1/89–9/30/89, COSTA RICA: INBIO: CRI104399. 1 ♀, Estac. Quebrada Bonita, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, 9/1/89–9/30/89, CRI1065549. 1 ♀, Estac. Santa Rosa, Prov. Guanacaste, L-N-313000-359800, Jul. 1990, COSTA RICA: INBIO: CRI1109032. 1 ♀, Estacion Mengo, Prov. Guanacaste, L-N-323300-375700, D.H. Janzen, 6/13/87–6/26/87, COSTA RICA: INBIO: CRI1115616. 1 ♂, same data as above except: D.H. Janzen & W. Hallwachs, 7/1/87–7/31/87, COSTA RICA: INBIO: CRI1115615. 2 ♀♀, Playa Naranjo, 0–100m, P.N. Sta. Rosa, Prov. Guanacaste, L-N-309300-354200, E. Alcazar, May-1991, COSTA RICA: INBIO: CRI386771, CRI386772. 1 ♂, same data as above except: Oct. 1990-COSTA RICA: INBIO: CRI70149, 1 ♂, Rancho Quemado, 200m, Peninsula de Osa, Prov. Puntarenas, L-S-292500-511000, F. Quesada, COSTA RICA: INBIO: CRI483369. 2 ♂♂, Santa Rosa National Park, Prov. Guanacaste, L-N-313000-359800, D.H. Janzen & W. Hallwachs, 20–22 May 1980-COSTA RICA: INBIO: CRI110543, CRI110540. 1 ♂, same data as above except: 1–15 Aug. 1982, COSTA RICA: INBIO: CRI1103541, 23–25 Jun. 1980, CRI1103542. 1 ♂, Sirena Corcovado, Prov. Puntarenas, L-S-270500-508300, D.H. Janzen & W. Hallwachs, 5/1/84, COS-

TA RICA: INBIO: CRI1110125. 3 ♂♂, 5 ♀♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, D.H. Janzen & W. Hallwachs, 12 July 1980-COSTA RICA: INBIO: CRI1115178, genitalia slide USNM 103, 726, COSTA RICA: INBIO: 10-12 JUL. 1980-CRI1115142, 1 May 1980-CRI1115140, 12-14 May 1980-CRI1115146, 23-25 May 1980-CRI1115151, 20-22 May 1980-CRI1115149, 7-8 May 1980-CRI1115150, 1-15 Aug. 1982-CRI1115183. 3 ♂♂, 2 ♀♀, same data as above except: D.H. Janzen, 10-12 Nov. 1979, COSTA RICA: INBIO: CRI1115139, CRI1115152, CRI1115141, 22-24 Jun. 1979, CRI1115148, 23-25 Nov. 1979, CRI1115145. 2 ♂♂, 3 ♀♀, Sirena, Corcovado National Park, Osa Peninsula, COSTA RICA, DH Janzen & W. Hallwachs, 1 May 1984-COSTA RICA: INBIO: CRI1115144, 5-11 Jan. 1981-CRI1115143, 10-12 Aug. 1980-CRI1115180, CRI1115179, CRI1115185, genitalia slide USNM 103, 727. 2 ♀♀, same data as above except: 13 Aug. 1980-CRI1115176, CRI1115177. 1 ♂, 1 ♀, Estacion Mengo, 1100m SW side Volcan Cacao, Prov. Guanacaste, COSTA RICA, 13-26 Jun. 1987, D.H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115138, CRI1115181. 1 ♀, 4 km E Casetilla, Rincon National Park, Prov. Guanacaste, COSTA RICA, 22 May 1982, 750m el, DH Janzen & W. Hallwachs, CRI1115147. 2 ♀♀, W of Carmona Nicoya, Prov. Guanacaste, COSTA RICA, 600-700m, 19 Aug. 1982, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115182, CRI1115184. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, 1-15 Aug. 1982, 300m DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115159; GUATEMALA: 3 ♂♂, 7 ♀♀, Cayuga; PANAMA: 4 ♂♂, 5 ♀♀, Barro Colorado; 1 ♂, Alhajuelo; 1 ♂, Cerro Campana, near Chica; MONTSERRAT: 2 ♂♂; DOMINICA: 1 ♂, 1 ♀; FRENCH GUIANA: 2 ♂♂, St. Jean; 2 ♂♂, St. Laurent; 1 ♂, Cayenne; VENEZUELA: 4 ♂♂, 7 ♀♀, Guarica. 2 ♂, 1 ♀, Aroa. 1 ♂, Valera. 1 ♂, Brainas. 1 ♀, San Estaban. 1 ♀, Lara. 1 ♀, Aragua; PERU: 1 ♂, "Peru"; PARAGUAY: 2 ♀♀, Dept. Paraguari. 1 ♀, Dept. Concepcion.

Distribution. Western Mexico and the Caribbean islands south to Paraguay.

Dicymolomia Zeller

This genus currently includes 9 species (Munroe 1983, 1995) and occur from the United States to South America; only 1 species occurs in Costa Rica. Feeding habits are believed to be diverse for this genus (Munroe, 1972).

Dicymolomia metalophota (Hampson)

Fig. 40

Ambia metalophota Hampson, 1897:166; Munroe, 1964:1300. NEW COMBINATION.

Lipocosma consortalis Dyar, 1914; Munroe, 1972:246. NEW COMBINATION, NEW SYNONYMY.

Bifalculina argentipunctalis Amsel, 1956; Munroe, 1972:246. NEW COMBINATION, NEW SYNONYMY.

Diagnosis. Apical and tornal areas and antemedial line of fore wing brownish-orange. Outer margin of hind wing slightly emarginate near M_2 ; four black marginal spots between M_2 and CuP; a linear cluster of black piliform scales between CuA₂

and CuP. Male genitalia with outer margin of valva semicircular; a stout spine at apex of costa of valva; vesica of aedeagus with many short spines. Female genitalia with ductus bursae produced from anterior portion of corpus bursae, posterior part of ductus bursae membranous, anterior part sclerotized.

Type. *A. metalophota*, holotype, ♀, Jamaica (BMNH). *L. consortalis*, holotype, ♂, Panama, genitalia slide USNM 107,364 [green label], Type. No. 16169 [red label] (USNM). *B. argentipunctalis*, holotype, ♀, Venezuela (ZSBS).

Material examined. Holotype not dissected. Other specimens examined: GUATEMALA: 1 ♂, Quirigua; 2 ♂♂, 5 ♀♀, Cayuga; COSTA RICA: 2 ♀♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, DH Janzen, 12 Dec. 1978–10 Jan. 1979–COSTA RICA: INBIO: CRI1115154, genitalia slide USNM 103, 791, CRI1115156. 1 ♂, same data as above except: 29–31 May 1979, COSTA RICA: INBIO: CRI115153, genitalia slide USNM 103, 790. 1 ♂, same data as above except: DH Janzen & W. Hallwachs, 26–28 Jun. 1980, COSTA RICA: INBIO: CRI115155, genitalia slide USNM 107,932. 1 ♀, Est. Pitilla, 700m, 9km S Sta. Cecilia, Prov. Guanacaste, COSTA RICA, P. Rios & C. Moraga, 10 Sept.–22 Oct. 1980, L-N-330200-380200, COSTA RICA: INBIO: CRI183485. 1 ♂, Cerro Tortuguero, 0–120m, P.N. Tortuguero, Prov. Limon, L-N-285000-588000, J. Solano, Nov. 1989, COSTA RICA: INBIO: CRI140608. 1 ♀, Est. Bijagual, 500m, Res. Biol. Carara, Prov. Puntarenas, L-N-192250-474760, R. Zuniga, Nov. 1989, COSTA RICA: INBIO: CRI116292, CRI116343. 1 ♀, same data as above except: Sept. 1990, COSTA RICA: INBIO: CRI296131. 2 ♂♂, Est. Maritza, 600m, lado O. Vol. Orosi, Prov. Guanacaste, L-N-326900-373000, I Curso Microlepidoptera, Jul. 1990, COSTA RICA: INBIO: CRI179519, CRI180932. 1 ♀, Est. Murcielago, 8km SW de Cuajiniquil, Prov. Guanacaste, L-N-320300-347200, I Curso Microlepidoptera, COSTA RICA: INBIO: CRI226435. 1 ♀, Est. Pitilla, 700m, 9km S Sta. Cecilia, L-N-320200-380200, C. Moraga & P. Rios, COSTA RICA: INBIO: CRI183560. 1 ♀, same data as above except: Sept. 1989, COSTA RICA: INBIO: CRI1936. 1 ♀, same data as above except: Dec. 1989, COSTA RICA: INBIO: CRI81185. 1 ♀, same data as above except: COSTA RICA: INBIO: CRI1064369. 1 ♂, 2 ♀♀, same data as above except: P. Rios & C. Moraga, 10 Sept.–22 Oct. 1990, COSTA RICA: INBIO: CRI183484, CRI183503, CRI183507. 1 ♀, same data as above except: GNP Biodiv. Survey, 1989, COSTA RICA: INBIO: CRI111728. 1 ♀, Est. Sta. Rosa, 333m P.N., Prov. Guanacaste, L-N-313000-359800, I Curso Microlepidoptera, Jul. 1990, COSTA RICA: INBIO: CRI224013. 1 ♀, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, L-S-370900-449800, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI227002. 1 ♀, same data as above except: R. Zuniga, Feb. 1991, COSTA RICA: INBIO: CRI346844. 1 ♀, same data as above except: 140m, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI227007. 1 ♂, 1 ♀, same data as above except: 80m, L-S-370900-448800, R. Zuniga, Feb. 1991, COSTA RICA: INBIO: CRI346913, CRI347104. 1 ♂, same data as above except: Jan. 1991, COSTA RICA: INBIO: CRI366866. 1 ♀, Sector Cerro Cocori, Fca. de E. Rojas, 150, Prov. Limon, L-N-286000-567500, E. Rojas, Mar. 1991, COSTA RICA: INBIO: CRI181536. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, 2–11 Mar. 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115160; CUBA: 4 ♂♂, 8 ♀♀, Santiago. 2 ♀♀, Sierra Maestra. 1 ♀, Havana; JAMAICA: 1

♂; GRENADA: 1 ♂; FRENCH GUIANA: 3 ♂♂, 2 ♀♀; VENEZUELA: 2 ♀♀, Valera.

Distribution. Southeastern United States, Guatemala southeast to Venezuela, including the Caribbean Islands.

Remarks. Munroe (1972) reports an unconfirmed record of *D. metalophota* feeding on *Cajanus cajan* (L.) Millsp.

Eupoca Warren

This genus includes 7 species (Munroe, 1995) and occurs from Mexico south to Brazil. Four species occur in Costa Rica: *E. bifascialis*, *E. chicalis*, *E. sanctalis* and new species, *E. haakei*. No biological information is available.

The generic placement of *Eupoca haakei* Solis & Adamski is tenuous. The wing patterns of many *Eupoca* are similar. The ground color is usually dark, and the antemedial and subterminal lines are well defined with white or pale brown scales. Some species, *E. chicalis* (Schaus) and *E. haakei*, have the fore wing veins on the upper surface delineated by lightly pigmented scales. Genital characters are problematical because several species are known only from one sex (mostly females) making even a preliminary study of these structures incomplete. Species with males known have a sclerotized, elongate costa of the valva with apical setae, and the valva is usually broad. The vinculum-saccus complex is ventrally quadrate. Cornuti are present or absent. The ductus bursae and corpus bursae may be heavily sclerotized, possessing several kinds of structures, or entirely membranous (Figs. 27–28).

Eupoca bifascialis (Walker)

Fig. 41

Nephopteryx bifascialis Walker, 1863:59; Munroe, 1964:1290. NEW COMBINATION.

Eupoca cinerea Warren, 1891:64; Munroe, 1964:1290. NEW SYNONYMY.

Diagnosis. All fasciae on fore wing dark brown near costa, except basal fascia light brown. Interneural spots dark brown. Antemedial, postmedial, and subterminal lines faint white. Male genitalia with uncus long and narrow. Valva broadened apically. Juxtal arms extending dorsolaterally to near apex of uncus. Female genitalia with posterior margin of seventh sternum rounded. Ductus bursae dorsally sclerotized, spinose posteriorly. Inner surface of corpus bursae with many stout spines laterally and less stout spines dorsoventrally.

Types. *N. bifascialis*, holotype, ♀, Brazil (BMNH). *E. cinerea*, syntype, ♂, Brazil (BMNH).

Material examined. Holotype not dissected. Other specimens examined: MEXICO: 2 ♀♀, Orizaba. 1 ♀, Jalapa; GUATEMALA: 1 ♂, 6 ♀♀, Volcan Santa Maria. 1 ♂, 2 ♀♀, Cayuga; COSTA RICA: 1 ♀, Juan Vinas. 1 ♂, 1 ♀, Turrialba. 1 ♂, 1 ♀, San Jose. 1 ♀, "Costa Rica"; ECUADOR: 2 ♂♂, "Environs de Loja"; COLOMBIA: 1 ♂, Urrao; VENEZUELA: 2 ♀♀, Aroa. 2 ♀♀, El Valle; FRENCH GUIANA: 1 ♀, St. Laurent; BRAZIL: 1 ♀, Castro; ARGENTINA: 1 ♂, Metan.

Distribution. Southern Mexico south to north central Argentina.

Eupoca chicalis (Schaus)

Figs. 8, 27, 42

Scybalista chicalis Schaus, 1920:178; Munroe, 1964:1290. NEW COMBINATION.

Diagnosis. Fore wing veins delineated by white scales, except anal veins from subterminal line; subterminal and antemedial lines white; antemedial line wider than subterminal line, apical and subapical areas brown. Hind wing uniformly gray. Male genitalia with costa of valva three thin, short apical spines; sacculus with hairlike setae. Female genitalia with posterior portion of ductus bursae membranous, anterior portion sclerotized, signum bladelike and deeply invaginated; inner surface of corpus bursae with short peglike spines, their bases fused forming a distinct sclerotized area, anterior portion membranous.

Type. Holotype, ♀, Cayuga, Guat[emala], May, Schaus and Barnes Coll[ection], genitalia slide USNM 107,901 [green label], Type No. 23528 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: GUATEMALA: 1 ♀, Cayuga; COSTA RICA: 1 ♂, Turrialba. 1 ♀, Finca La Selva (OTS), Puerto Viejo de Sarapiquí, Prov. Heredia, 50m, COSTA RICA, 6–9 Mar. 1985, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115157, genitalia slide USNM 108,108. 1 ♀, Sirena, Corcovado National Park, Osa Peninsula, COSTA RICA, 5–11 Jan. 1981, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115158. 1 ♂, Est. Quebrada Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Aug. 1990, COSTA RICA: INBIO: CRI181205. 1 ♀, Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Mar. 1991, COSTA RICA: INBIO: CRI300007. 1 ♀, Apr. 1991, COSTA RICA: INBIO: CRI475681. 1 ♀, Fca. San Gabriel, 2km S Dos Rios, Prov. Alajuela, L-N-318800-383500, GNP Biodiv. Survey, 5/1/89–5/31/89, COSTA RICA: INBIO: CRI27. 1 ♂, Quepos, 120m, P.N. Manuel Antonio, Prov. Puntarenas, L-S-370900-449800, COSTA RICA, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI180495. 1 ♀, P.N. Manuel Antonio, 80m, Quepos, Prov. Puntarenas, L-S-370900-448800, R. Zuniga, Feb. 1991, COSTA RICA: INBIO: CRI347142. 1 ♀, same data as above except: Jan. 1991, COSTA RICA: INBIO: CRI366971. 1 ♂, Sirena Corcovado, N.P. Prov. Puntarenas, L-S-270500-508300, R. Blanco & G. Fonseca, 4/1/89–4/30/89, COSTA RICA: INBIO: CRI1103081. 1 ♀, Sirena, Corcovado National Park, Prov. Puntarenas, L-N-270500-508300, COSTA RICA, 100m, Nov. 1989, J. Solano, COSTA RICA: INBIO: CRI11387, genitalia slide USNM 107,934. 1 ♀, Cerro Tortuguero, P.N., Tortuguero, Prov. Limon, L-N-285000-588000, COSTA RICA, 100m, Nov. 1989, J. Solano, COSTA RICA: INBIO: CRI140671; PANAMA: 1 ♀, Barro Colorado Is.; FRENCH GUIANA: 1 ♂, St. Jean du Maroni.

Distribution. Guatemala southeast to French Guiana.

Eupoca haakei, new species

Figs. 28, 43

Diagnosis. Ground color of fore wing upper surface brown, with wing veins delineated by pale brownish-yellow scales. Female corpus bursae with accessory lobe on anterior end; signum absent.

Description. Head: Vertex with brownish-yellow scales. Frontoclypeus with pale brown scales (most specimens are missing [rubbed] scales on frontoclypeus). Antennal scape and pedicel with pale brown scales, flagellomeres with nonoverlapping pale brown scales on posterior surface. Ocellus present. Maxillary palpus pale brown. Labial palpus with basal segment mostly brown, intermixed with white and pale brown scales distally, distal segments pale brown. Proboscis with basal pale brown scales.

Thorax: Tegula brown basally, pale brown distally. Mesoscutum mostly pale brown, intermixed with brown scales. Prothoracic coxa and outer surface of femur white; inner surface of femur and tarsomeres pale brown, darker near epiphysis and basal two-thirds of first tarsomere. Pterothoracic legs white, except apex of midfemur brown. Fore wing length = 7.8–9.5 mm (N = 6). Ground color mostly brown, intermixed with white and pale brown scales. Distal portion of subterminal area pale brown. Marginal line brown. Fringe scales pale brown basally, brown distally. Under surface mostly pale brown, darker from costa to 1A+2A. Both surfaces of hind wing pale brown with brown marginal line.

Abdomen: Upper surface of each terga with a transverse median brown band, basally and distally pale brown. Under surface white, intermixed with pale brown scales.

Male genitalia: Unknown.

Female genitalia: Ductus bursae and corpus bursae entirely membranous. Corpus bursae with an accessory lobelike structure on anterior end. Ductus seminalis broadened basally.

Types. Holotype: ♀, Sirena, Corcovado Nat.[ional], P[ar]k, Osa Penin.[sula], COSTA RICA, 5–11 Jan[uary] 1981, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1115175, genitalia slide USNM 107,894 [green label] (INBIO). Paratypes: 1 ♀, same label data as holotype except; COSTA RICA: INBIO: CRI1115174, genitalia slide USNM 108,107 [green label]. 1 ♀, 10–12 Aug[ust] 1980, COSTA RICA: INBIO: CRI1115173. 1 ♀, P.N. Manuel Antonio, 80m, Quepos, Prov[incia] Punt[renas], COSTA RICA, G. Varela, Nov[ember] 1991, L-S-370900,448800, COSTA RICA: INBIO: CRI404017, genitalia slide 107,924 [green label]. 1 ♀, Quepos, 120m, P.N. Manuel Antonio, Prov. [incia] Punt. [renas], COSTA RICA, G. Varela & R. Zuniga, Oct[ober] 1990, L-S-370900, 440800, COSTA RICA: INBIO: CRI274834. 1 ♀, Quepos, 140m, P.N. Manuel Antonio, Prov.[incia] Punt.[renas], COSTA RICA, G. Varela & R. Zuniga, Oct[ober] 1990, L-S-371500,9450, COSTA RICA: INBIO: CRI223013 [abdomen not dissected in gelatin capsule].

Distribution. Southeastern Costa Rica at low elevations.

Etymology. This species is named in honor of Michael Haake of Texas, in recognition of George Haake's support of the development of INBio.

Eupoca sanctalis (Schaus)

Fig. 44

Scybalista sanctalis Schaus, 1912a:289; Munroe, 1964:1290. NEW COMBINATION.

Diagnosis. Fore wing with apical, subapical, and tornal areas brown; medial area

mostly light brown; antemedial and subterminal lines white, jagged. Hind wing uniformly gray with narrow marginal line. Male genitalia with valva wide distally; costa of valva with two stout, short apical apines; cornutus of vesica with two spines, the larger spine nearly the entire length of aedeagus. Female genitalia with posterior portion of ductus bursae membranous; proximal portion of ductus seminalis with a linear row of spines that bifurcates, forming an irregular ring of spines within the corpus bursae.

Type. Holotype, ♀, Jan[uary], Juan Vinas, C[osta] R[ica], genitalia slide USNM 107,900 [green label], Type No. 17564 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: COSTA RICA: 1 ♀, Juan Vinas (paratype, specimen with abdomen missing); COLOMBIA: 1 ♂, San Antonio.

Distribution. Central Costa Rica south to northern Colombia.

Glaphyria Hübner

The entire taxon consists of 34 species in the Western Hemisphere. Seven species occur in Costa Rica: *G. citronalis*, *G. decisa*, *G. rufescens*, and 4 new species, *G. spinacrista*, *G. spinasingularis*, *G. stellaspina*, *G.* and *tetraspina*. No biological information is available.

The placement of *Glaphyria* species is based on Munroe (1972) whose diagnosis of the Nearctic *Glaphyria* is summarized as follows: male genitalia (Figs. 14–19) with a slender uncus, distally pointed and hooked ventrally; juxta deeply U-shaped with dorsal apices spinose; valva fan-shaped, with a tubular costa, ending in a short, sharp process beyond middle; aedeagus cylindrical and with cornutus; female genitalia (Figs. 29–32) with ductus bursae strengthened by a fluted sclerite; bursa pouch-like, with a diverticulum leading to the ductus seminalis. In addition, most male genitalia of *Glaphyria* have the costa of the valva sclerotized, and in both males and females the wing scale color is generally pale brown or yellow with lines white or brown bordered by white.

Glaphyria citronalis (Druce)

Fig. 45

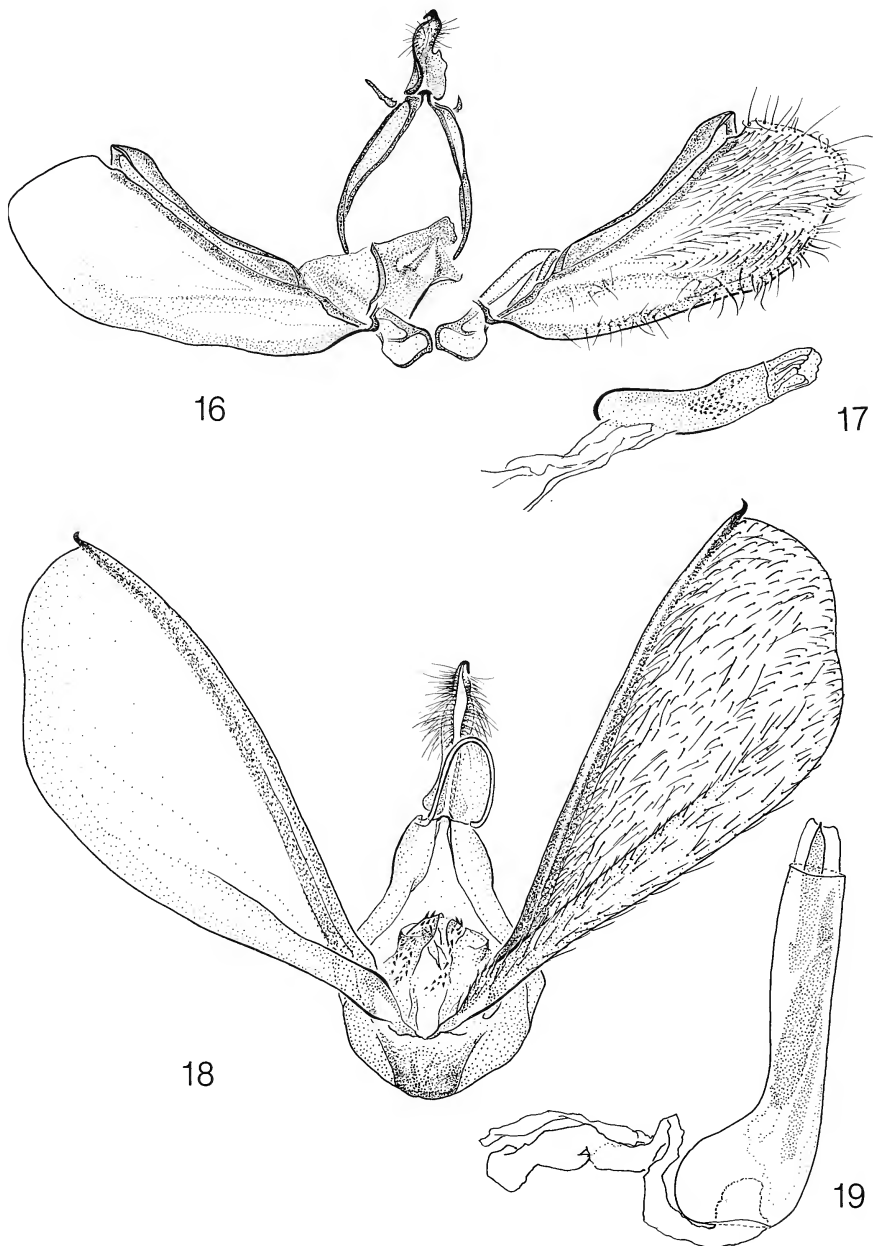
Homophysa citronalis Druce, 1899:556.

Glaphyria citronalis Druce, 1899; Klima, 1939:10. NEW COMBINATION.

Diagnosis. Fore wing with four transverse yellow apical streaks. Ductus bursae and medial portion of corpus bursae of female genitalia with sclerotized pleats; base of ductus seminalis with peglike spines.

Types. *H. citronalis*, holotype, ♀, Atoyac, Vera Cruz, BM slide no. 11414 (BMNH).

Material examined. Holotype dissected. Other specimens examined: MEXICO: 1 ♂, Atoyac, Vera Cruz; COSTA RICA: 1 ♀, Est. Bijagual, 500m, Res. Biol., Carara, Prov. San Jose, L-N-192250-474760, COSTA RICA, R. Zuniga, Sept. 1990, COSTA RICA: INBIO: CRI299452, genitalia slide USNM 107,956. 1 ♀, Quepos, 120m, P.N. Manuel Antonio, Prov. Puntarenas, L-S-370900-449800, COSTA RICA, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI227960, genitalia slide USNM 107,957. 1 ♀, Est. Hitoy Cerere, 100m, R. Cerere, Res. Biol. Hitoy Cerere, Prov.



Figs. 16–19. 16. Male genitalia of *Glaphyria stellaspina*, USNM #107,920. 17. Aedeagus of *Glaphyria stellaspina*, USNM #107,920. 18. Male genitalia of *Glaphyria tetraspina*, USNM #107,935. 19. Aedeagus of *Glaphyria tetraspina*, USNM #107,935.

Limon, L-N-643400-184600, M. Barrelier, Oct. 1990, COSTA RICA: INBIO: CRI314043.

Distribution. Southeastern Mexico south to Central America and Brazil.

Remarks. Male unknown.

Glaphyria decisa (Walker)

Fig. 46

Acontia? decisa Walker, [1866]: 1963.

Homophysa pomonalis Schaus, 1920:174; Munroe, 1995:43. NEW SYNONYM.

Diagnosis. Fore wing with medial fascia brown, except costa and other wing areas mostly yellow. Hind wing area between CuA_2 and CuP with or without spatulate scales. Valva of male genitalia with a broadly rounded subapical membranous projection on costa; vinculum with vertically oriented lateral struts. Female genitalia with small membranous fold posterior to ostium bursae; margin of seventh sternum rounded and produced posteriorly; two small lateral sclerotizations within ductus bursae equidistant to ostium bursae and inception of corpus bursae; two large sclerotizations within corpus bursae, one elongate, the other subcircular and funnel-shaped.

Types. *A. decisa*, holotype, Jamaica (BMNH). *H. pomonalis* Schaus, holotype, Cayuga, Guatemala, Type No. 23518 [red label] (USNM).

Material examined. Holotypes not dissected (abdomens missing). Other specimens examined. GUATEMALA: 3 ♂♂, 5 ♀♀, Cayuga; COSTA RICA: 1 ♀, Estac. Bijagual, 500m, Res. Biol. Carara, Prov. San Jose, L-N-192250-474760, COSTA RICA, R. Zuniga, Jan. 1990, COSTA RICA: INBIO: CRI104522, genitalia slide USNM 107,940. 1 ♀, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, L-S-370900-449800, R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI227888; FRENCH GUIANA: 2 ♀♀, Cayenne. 1 ♀, St. Laurent; PARAGUAY: 1 ♀, Villarrica; CUBA: 1 ♂, 2 ♀♀, Santiago. 1 ♀, Havana.

Distribution. Guatemala south to southeastern Paraguay, including Cuba.

Remarks. Hind wing area between CuA_2 and CuP with or without spatulate scales, consequently this species can be found in two different parts of the key.

Glaphyria rufescens (Hampson)

Fig. 47

Scybalista rufescens Hampson, 1912:158.

Glaphyria rufescens Hampson, 1912; Munroe, 1995:43. NEW COMBINATION.

Diagnosis. Fore wing ground color pale brown. Antemedial and postmedial lines brown, faint. Hind wing pale brown, postmedial line brown, faint; anal area with brown scales, sparsely distributed; area between CuA_2 and CuP with scales with a linear base and spatulate apex. Female genitalia with a membranous fold lateral to ostium bursae; ductus bursae sclerotized anteriorly; ductus seminalis sclerotized only at base; corpus bursae with several sclerotized longitudinal pleats.

Type. Holotype, ♀, Panama (BMNH).

Material examined. Holotype not dissected. Other specimens examined: COSTA RICA: 1 ♀, Tuis, genitalia slide USNM 107,984.

Distribution. Costa Rica south to Panama.

Remarks. Male unknown.

Glaphyria spinacrista, new species

Figs. 29, 48

Diagnosis. Fore wing and hind wing with antemedial line absent. Male genitalia unknown. Female with ductus bursae sclerotized throughout length, with a spined ridge lateral to ostium bursae, and ventrally excavated anteriorly.

Description. Head: Vertex and frontoclypeus pale brown, intermixed with white scales; antennal scales pale brown. Ocellus present. Maxillary palpus white. Outer and inner surfaces of each article of labial palpus basally and apically white with pale brown scales between. Proboscis pale brown, intermixed with brown and white scales.

Thorax: Tegula and mesonotum with pale brown scales tipped with brown. Prothoracic leg white, except inner surfaces of femur, tibia, and tarsomere. Pterothoracic legs white. Fore wing length = 6.5–6.7 mm (N = 4). Ground color pale brown, most scales pale brown tipped with brown, intermixed with pale brown scales. Postmedial and subterminal lines brown. Postmedial line proximally demarcated with pale brown scales, subterminal line demarcated distally with similarly pigmented scales. Antemedial line present. Interneural dots elongate. Distal scales of fringe mostly white or pale brown tipped with brown, intermixed with white scales, and next inner line of fringe scales pale brown tipped with brown. Under surface similarly patterned, except for the absence of postmedial line and the presence of a small brown dot in cell. Hind wing similarly patterned as fore wing, except antemedial line absent. Area between CuA_2 and CuP with elongate, spatulate scales, each scale pale brown tipped with brown. Under surface similarly patterned as fore wing.

Abdomen: Scales mostly pale brown intermixed with pale brown scales tipped with brown.

Male genitalia: Unknown.

Female genitalia: Papillae anales laterally flattened. One pocketlike structure in membrane posterior to ostium bursae. Posteroventral margin of seventh segment sclerotized and emarginate. Ductus bursae sclerotized throughout length, with a spined ridge lateral to ostium bursae, and ventrally excavated anteriorly. Area between inception of ductus seminalis and inception of ductus bursae with linear spines, spines in a short irregular row. Midventral portion of corpus bursae with small spines, mid-dorsal portion with sclerotized pleats, anterior part of corpus bursae membranous.

Types. Holotype: ♀, Santa Rosa National Park, Guanacaste Pro. [vincia], COSTA RICA, 2–11 Mar[ch] 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1103537, genitalia slide USNM 107,919 [green label]. (INBIO). Paratypes: 1 ♀, same data as holotype except; COSTA RICA: INBIO: CRI1109320, genitalia slide USNM 103,672 [green label]. 1 ♀, same data as holotype except; COSTA RICA: INBIO: CRI1109319. 1 ♀, On bait, waterhole, Santa Rosa Nat.[ional] P[ar]k Prov.

[incia], Guanacaste, COSTA RICA, DH Janzen 5–14 Mar[ch] 1979, COSTA RICA: INBIO: CRI1109317.

Distribution: Northwestern Costa Rica.

Etymology. The species epithet is from the spined ridge of the ostium bursae in the female genitalia: Latin “spina” meaning thorn and “crista” meaning ridge.

***Glaphyria spinasingularis*, new species**

Figs. 14–15, 30, 49

Diagnosis. Fore wing pale brown, except medial fascia brown. Costa of valva with apex produced into a single stout spine; vinculum ventrally bilobed. Female seventh sternum produced posteriorly into a medial lobe.

Description. Head: Vertex and frontoclypeus mostly yellow intermixed with white scales or mostly white intermixed with yellow scales. Antennal scape white, flagellum with alternating white and pale brown scales. Ocellus present. Maxillary palpus white. Outer surface of articles of labial palpus basally and apically white with yellow between; inner surface paler or white. Proboscis with white basal scales.

Thorax: Tegula and mesonotum mostly white intermixed with yellow. Inner surface of most thoracic leg segments and tarsomeres basally yellow, distally white; outer surface mostly white intermixed with yellow and/or pale brown scales. Fore wing length = 6.3–7.3 mm (N = 4). Most wing scales basally white, apically brown. Medial fascia pale brown. Subterminal and antemedial lines white, the latter faint. Some specimens have yellow scales intermixed with pale brown scales along costa. Marginal line pale brown, proximally bordered by white. Fringe scales pale brown or white. Under surface uniform in pattern, except apical area yellow, intermixed with pale brown scales, and a small brown spot in cell. Hind wing with anal and cubital areas pale brown. Postmedial line white, faint. Marginal line pale brown. Fringe scales as fore wing. Area between CuA₂ and CuP with or without spatulate scales, and if present they are basally white, tipped with white.

Abdomen: Upper surface scales white, tipped with brown, intermixed with white scales.

Male genitalia: Uncus with apex hooked ventrally. Vinculum ventrally bilobed. Costa of valva recurved; apex of costa produced into a single stout spine, laterally dilated at base. Juxta elongate and distally spinose. Cornutus with three spines.

Female genitalia: Eight pocketlike structures in membrane posterior to ostium bursae. Seventh sternum with a medial and two lateral lobes. Ductus bursae membranous posteriorly, sclerotized anteriorly. Corpus bursae with anterior portion spinose.

Types. Holotype: ♀, Santa Rosa National Park, Guanacaste Prov.[incia], COSTA, RICA, 2–4 May 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI110931, genitalia side USNM 103,785, [green label] (INBIO). Paratypes: 1 ♂, Santa Rosa Nat.[ional] P[ar]k, Prov.[incia], Guanacaste, COSTA RICA, 7–9 Nov[ember] 1979, D.H. Janzen, COSTA RICA: INBIO: CRI1109314, genitalia slide USNM 107,933 [green label]. 1 ♀, Santa Rosa National Park, Guanacaste Prov.[incia], COSTA RICA, 23–25 May 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109316. 1 ♀, Santa Rosa National Park, Guanacaste

Prov.[incia], COSTA, RICA, 20–22 May 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109315.

Distribution: Northwestern Costa Rica.

Etymology. The specific epithet is based on the presence of a spine on the costa of the male valve: Latin “spina” meaning spine and “singularis” meaning single.

Remarks. Area between CuA_2 and CuP with or without spatulate scales, consequently this species can be found in two different parts of key.

Glaphyria stellaspina, new species

Figs. 16–17, 31, 50

Diagnosis. Fore wing with antemedial fascia brownish-orange, except for yellow along costa; basal fascia white, except two yellow streaks along costa. Membranous valva extending beyond sclerotized costa. Anterior portion of corpus bursae with a network of spines, each spine with a stellate base.

Description. Head: Vertex and frontoclypeus white, some specimens with a yellow streak from inner margin of antennal socket to lateral margin of frontoclypeus. Antennal scales pale yellow. Ocellus present. Basal articles of maxillary palpus yellow, terminal article white. Outer surface of labial palpus with mostly white scales on basal article, intermixed with yellow scales apically, terminal articles mostly yellow, intermixed with brownish-yellow scales; inner surface white. Proboscis with basal white scales.

Thorax: Tegula and mesonotum mostly white intermixed with yellow scales. Prothoracic leg white, except for yellow scales on inner surfaces of femur, tibia, and all tarsomeres. Pterothoracic legs white, except for yellow scales on inner surfaces of tibia and tarsomeres, except for white apex. Fore wing length = 5.7–6.1 mm ($N = 3$). Antemedial and subterminal fasciae brownish-orange, except for yellow costa. Basal fascia white, but with two yellow costal streaks. Medial fascia white, one specimen with brown along posterior margin. Antemedial and postmedial lines brown posteriorly, obscure anteriorly. Marginal line brownish-orange, proximally demarcated with white scales. Fringe scales brownish-orange. Under surface with veins streaked with yellowish-brown scales; interneural areas white, except for brown patches in subterminal area. Hind wing with semitranslucent white scales basally, pale yellowish-orange scales distally to wing margin. Marginal scales brownish-orange. Fringe scales pale yellowish-brown. Area between CuA_2 and CuP with or without pale yellowish-brown piliform scales. Under surface patterned as fore wing.

Abdomen: Mostly white, intermixed with yellow scales, white underneath.

Male genitalia: Uncus apically hooked ventrally. Pseudognathos composed of two free arms, each basally fused dorsolaterally to tegumen. Vinculum ventrally bilobed, laterally dilated to costal base. Costa sclerotized, inwardly angled. Valva membranous, extending beyond costa. Ventral margin and median longitudinal portion of valva moderately heavily sclerotized. Juxta subtrapezoidal. Aedeagus ventrally angled, small spinules on vesica.

Female genitalia: Papillae anales laterally flattened. Eight to nine pocketlike structures in membrane posterior to ostium bursae. Ductus bursae dilated laterad to ostium bursae, fusing with posterolateral margin of seventh sternite. Anterior portion of

ductus bursae sclerotized. Corpus bursae posteriorly membranous and anteriorly with a network of spines.

Types. Holotype: ♂, Cerro Tortuguero 0–120m, P.N. Tortuguero, Prov.[incia], Limon COSTA RICA, R. Delgado, Ene 1992, L-N-285000.588000, COSTA RICA: INBIO: CRI332172, genitalia slide USNM 107,920 [green label]. Paratypes: 1 ♀, Est. [acion] Cuatro Esquinas, P.N. Tortuguero, 0m, Prov.[incia], Limon, COSTA RICA, J. Solano, Oct[ober] 1990, L-N-280000.5905000, COSTA RICA: INBIO: CRI178922, genitalia slide USNM 105,822 [green label]. 1 ♀, same data as previous paratype except COSTA RICA: INBIO: CRI178955, genitalia slide USNM 107,921 [green label]. All paratypes deposited in the USNM.

Distribution. Northeastern Costa Rica.

Etymology. The species epithet is derived from the spines with a stellate-shaped base on the corpus bursae: Latin “stella” meaning star and “spina” meaning spine.

Remarks: Area between CuA₂ and CuP with or without pale yellowish-brown piliform scales, consequently this species can be found in two different parts of key.

***Glaphyria tetraspina*, new species**

Figs. 18–19, 32, 51

Diagnosis. Fore wing with antemedial and postmedial lines present (the former may be obscure). Costa of valva with apex produced into a short recurved spine; cornutus four large spines. Ductus bursae long, sclerotized; inception of ductus bursae on anterior part of corpus bursae.

Description. Head: Vertex white (in one specimen pale brown), except pale brown scales tuft near base of antenna; frontoclypeus mostly white, intermixed with pale brown scales medially. Antenna white. Ocellus present. Outer surface of maxillary palpus pale brown basally, white apically, or mostly white except pale brown on second article only, inner surface white. Outer surface of labial palpus with pale brown, except for white apices of second and third articles, inner surface white. Proboscis with basal white scales.

Thorax: Tegula and mesonotum mostly pale brown basally, intermixed with white scales, white distally. Prothoracic leg white, except pale brown on inner surfaces of femur, tibia, and basal tarsomeres. Pterothoracic legs white. Fore wing length = 5.6–6.9 mm (N = 5). Ground color brownish-orange; postmedial and subterminal lines white; antemedial line white or obscure. All lines when present demarcated with brown scales. Brown interneural dots present in one specimen only. Fore wing margin brown. Inner fringe scales with basal half pale brown, distal half brown; outer fringe scales white. Under surface pale brown with brown scales demarcating proximal side of subterminal line. A small brown dot present in cell. Interneural dots present in most specimens. Hind wing mostly white basally with pale brown scales demarcating postmedial line. A small brown dot present in cell. Area between postmedial line and wing margin with mostly brown scales, except white anal area. Wing margin brown; fringe scales as fore wing. Under surface pale brown, interneural dots present in most specimens. Area between CuA₂ and CuP without piliform or spatulate scales.

Abdomen: Upper surface of segments pale brown basally, white distally; under surface white.

Male genitalia: Uncus slightly constricted near basal third, terminating distally into an apical hook. Pseudognathos a narrow ringlike structure fused dorsolaterally to tegumen. Vinculum with a rectangular-shaped protuberant rim near posterior margin. Juxta narrowed basally, with spinose dorsal extensions. Costa of valva sclerotized, distally produced into a recurved apical spine. Lower margin of valval base overlapped by upper portion. Entire valva mostly membranous, except for costa. Aedeagus angled basally; cornutus with four large spines.

Female genitalia: Membrane posterior to ostium bursae with nine small pocketlike structures, oriented along median longitudinal body axis. Ductus bursae sclerotized, longitudinally pleated, laterally dilated fusing with posterior margin of seventh sternum. Area surrounding inception of ductus bursae similarly pleated. Ductus seminalis originates on posterior portion of corpus bursae; an irregular row of spines originates from base of ductus seminalis and continues in a spiral pattern to base of ductus bursae. A second spinose area on other side of ductus bursae, posterior to accessory bursae.

Types. Holotype: ♂, Santa Rosa Nat.[ional] P[ar]k., Prov.[incia], Guanacaste, COSTA RICA, 16–18 Nov[ember] 1979, D.H. Janzen, COSTA RICA: INBIO: CRI1109321, genitalia slide USNM 107,935 [green label]. Paratypes: 1 ♀, Santa Rosa National Park, Guana.[caste] Prov.[incia], COSTA RICA, 19–21 Jun[e] 1979, D.H. Janzen, COSTA RICA: INBIO: CRI1109322, genitalia slide USNM 107,936 [green label]. 1 ♀, Santa Rosa National Park, Guanacaste Prov.[incia] COSTA, RICA, 13–15 Jul[y] 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109323. 1 ♀, Santa Rosa National Park, Guana.[caste] Prov.[incia], COSTA RICA, 22–24 July 1979, D.H. Janzen, COSTA RICA: INBIO: CRI1109324. 1 ♀, Santa Rosa National Park, Guanacaste Prov.[incia], COSTA, RICA, 2–4 May 1980, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109318.

Distribution. Northwestern Costa Rica.

Etymology. The species epithet refers to the four spines that are the cornutus on the male aedeagus: Greek “tetra” meaning four and Latin “spina” meaning spine.

Hellula Guenée

The entire fauna of this genus is composed of 6 species in the Western Hemisphere (Munroe 1983, 1995) and one species in Europe (*H. undalis* F.). Only one species, *H. phidilealis* (Walker), occurs in Costa Rica. Two species, *H. phidilealis* and *H. rogatalis* (Hulst), are serious pests of Cruciferae in the Western Hemisphere, but larvae have also been reared on Amaranthaceae and Portulacaceae.

Hellula phidilealis (Walker, 1859)

Fig. 52

Leucochroma? *phidilealis* Walker, 1859:972; Munroe, 1964:1261. NEW COMBINATION.

Phyratocosma trypheropa Meyrick, 1936:323; Munroe, 1972:200. NEW COMBINATION, NEW SYNONYMY.

Diagnosis. Fore wing with a crescent-shaped grayish-brown spot near distal end of cell. Ventral margin of valva produced into a long spine, costa elbowed nearly 45

degrees. Ductus bursae flat, membranous near ostium bursae, remaining portion sclerotized, corpus bursae spinose posteriorly and membranous anteriorly.

Types. *L. phidilealis*, holotype, ♂, Venezuela (BMNH). *P. trypheropa*, holotype, ♀, Venezuela (BMNH).

Material examined. Holotypes not dissected. Other specimens examined: MEXICO: 1 ♀, Guadalajara; GUATEMALA: 2 ♂♂, Cayuga; EL SALVADOR: 2 ♂♂, St. Andres. 1 ♂, 3 ♀♀, Rio el Palmar (near La Libertad); COSTA RICA: 1 ♂, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, DH Janzen & W. Hallwachs, 25–27 Jul. 1980, COSTA RICA: INBIO: CRI1115162, genitalia slide USNM 107,952. 1 ♀, same data as above except: 7–9 Jul. 1980, COSTA RICA: INBIO: CRI1115161, genitalia slide USNM 103,725. 1 ♀, Cerro Tortuguero, 0–120m, P.N. Tortuguero, Prov. Limon, L-N-285000-588000, J. Solano, Oct. 1989, COSTA RICA: INBIO: CRI31764. 1 ♀, Est. Maritza, 600m, lado O Vol. Orosi, Prov. Guanacaste, L-N-326900-373000, I Curso Microlepidoptera, Jul. 1990, COSTA RICA: INBIO: CRI180963. 1 ♀, Est. Sta. Rosa, 300m, P.N. Sta. Rosa, Prov. Guanacaste, L-N-313000-359800, I Curso Microlepidoptera, Jul. 1990, COSTA RICA: INBIO: CRI224091. 2 ♂♂, same data as above except: COSTA RICA: INBIO: CRI224007, CRI224090. 1 ♂, Fca. Cafrosa, 1300m, Est. Las Mellizas, P. Internac. La Amistad, Prov. Puntarenas, M.M. Chavarria, Jan. 1991, COSTA RICA: INBIO: CRI380485. 1 ♀, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI180483. 1 ♀, same data as above except: G. Varela & R. Zuniga, Dec. 1990, COSTA RICA: INBIO: CRI229151. 1 ♂, same data as above except: Oct. 1990, COSTA RICA: INBIO: CRI223077. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, D.H. Janzen, 12/12/78–1/10/79, COSTA RICA: INBIO: CRI1103538. 1 ♂, Sirena, Corcovado Nat. Pk., Prov. Puntarenas, L-S-270500-508300, DH Janzen, 8/10/80–8/12/80, COSTA RICA: INBIO: CRI1103539. 2 ♂♂, San Jose Prov.; PANAMA: 1 ♀, Corozal; VENEZUELA: 1 ♂, 2 ♀♀, Zulia. 2 ♀♀, San Carlos; FRENCH GUIANA: 3 ♂♂, 3 ♀♀, Cayenne. 1 ♂, 1 ♀, St. Jean. 1 ♀, St. Laurent; COLOMBIA: 1 ♂, Caqueta; BRAZIL: 1 ♂, Pernambuco; CUBA: 2 ♀♀, Santiago. 1 ♂, Tanama; DOMINICAN REPUBLIC: 2 ♂♂, 1 ♀, Dajabon Prov.; JAMAICA: 2 ♂♂, St. Andrew Parish. 6 ♀♀, "Jamaica". 2 ♀♀, Portland Parish; PUERTO RICO: 1 ♂, Pta. Jacinto. 1 ♀, Isabela. 1 ♀, Mayaguez; ST CROIX: 2 ♂♂, 3 ♀♀, Expt. Sta.; DOMINICA: 2 ♂♂, 10 ♀♀, Clarke Hall; GRENADA: 2 ♀♀, Jamaica.

Distribution. Southern United States, southwestern Mexico to northern South America, including several islands in the Caribbean.

Homophysodes Dyar

A monotypic genus. No biological information is available.

Homophysodes morbidalis Dyar

Fig. 56

Homophysodes morbidalis Dyar, 1914:296.

Diagnosis. Fore wing with medial fascia and tornal area brown, except costa and other wing areas mostly yellow; two or three narrow and white apical streaks present.

Hind wing with a linear cluster of scales between CuA_2 and CuP , each scale with a very long base and spatulate apex. Vinculum v-shaped; costa of valva with an apical spine, pointing vertically. Posterior margin of seventh sternum truncate; anterior half of ductus bursae sclerotized, posterior half membranous; a sclerotization with free ribbonlike arms within corpus bursae.

Type. *H. morbidalis*, holotype, ♂, Trinidad Riv[er], Pan [ama], genitalia slide USNM 107,970 [green label], Type No. 16212 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: GUATEMALA: 1 ♂, 1 ♀, Cayuga; COSTA RICA: 1 ♂, Quepos, 120m P.N. Manuel Antonio, Prov. Puntarenas, L-S-370900-449800, COSTA RICA, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI180560, genitalia slide USNM 107,937. 1 ♀, Sirena, Corcovado Nat. Pk., Osa Peninsula, COSTA RICA, DH Janzen & W. Hallwachs, 10–12 Aug. 1980, COSTA RICA: INBIO: CRI1115191. 1 ♀, Sirena, Corcovado Nat. Pk. Osa Peninsula, COSTA RICA, DH Janzen & W. Hallwachs, 10–12 Aug. 1980, COSTA RICA: INBIO: CRI1115165. PANAMA: 1 ♂, Coraza. 1 ♀, Rio Trinidad.

Distribution. Guatemala south to Panama.

Lipocosma Lederer

This genus consists of 25 species (Munroe 1972, 1995) that are primarily neotropical in distribution. Eight species occur in Costa Rica: *L. albibasalis* (Hampson), *L. ausonialis* (Druce), *L. calla* (Kaye), *L. furvalis* (Hampson), *L. nigripictalis* Hampson, and 3 new species, *L. fonsecai*, *L. pitilla*, and *L. rosalia*. Two species have larvae that build cases that resemble the oak-encrusted lichens upon which they live; adult wing patterns also resemble the white lichen-encrusted oak trees (Munroe, 1972).

Three species have been placed in *Lipocosma* because they share a combination of several characters found in species figured by Munroe (1964, 1972). These characters include a body covered with mostly white scales, and male genitalia (Figs. 20–24) with a slender uncus (except *L. pitilla*), bifid juxta, and marginate valva. In addition, we found most species in this genus have a pseudognathos with a dorso-medial projection. Munroe (1964) stated that the genus is fairly homogenous, however we have found much variation.

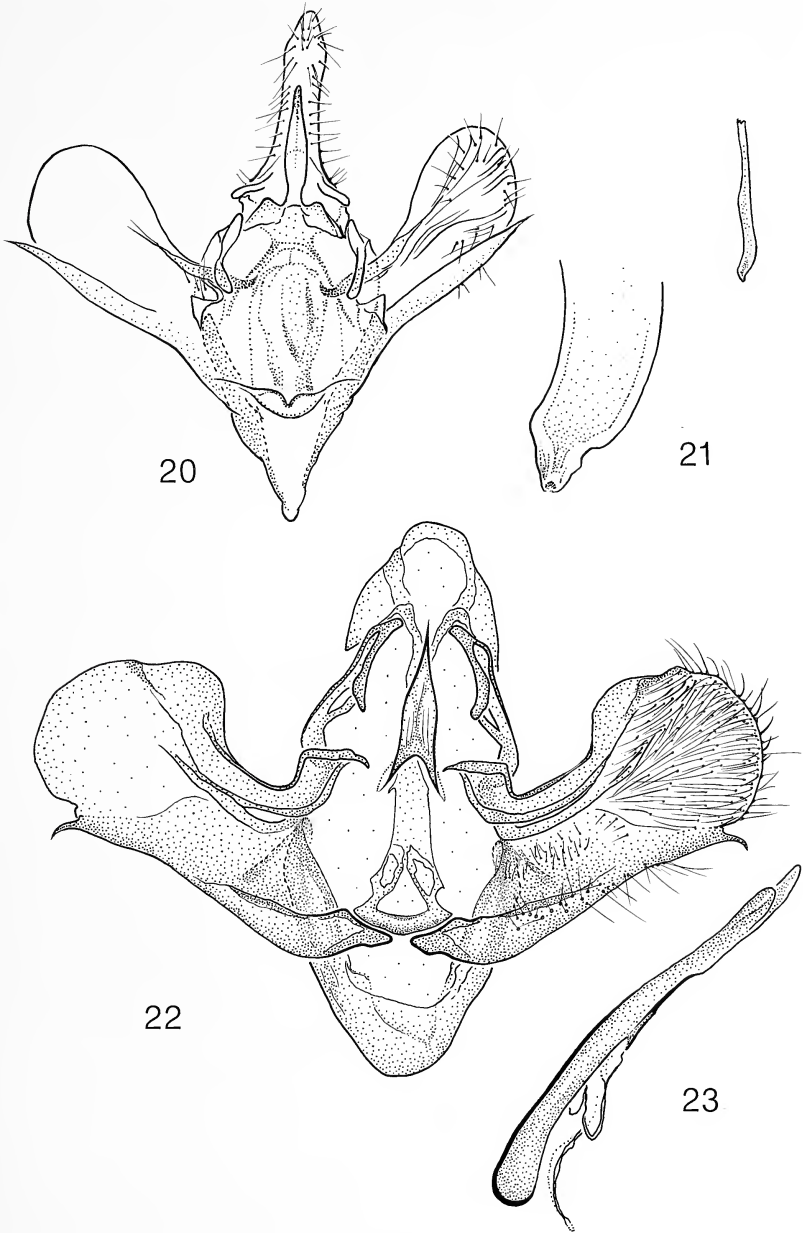
Lipocosma albibasalis (Hampson)

Fig. 57

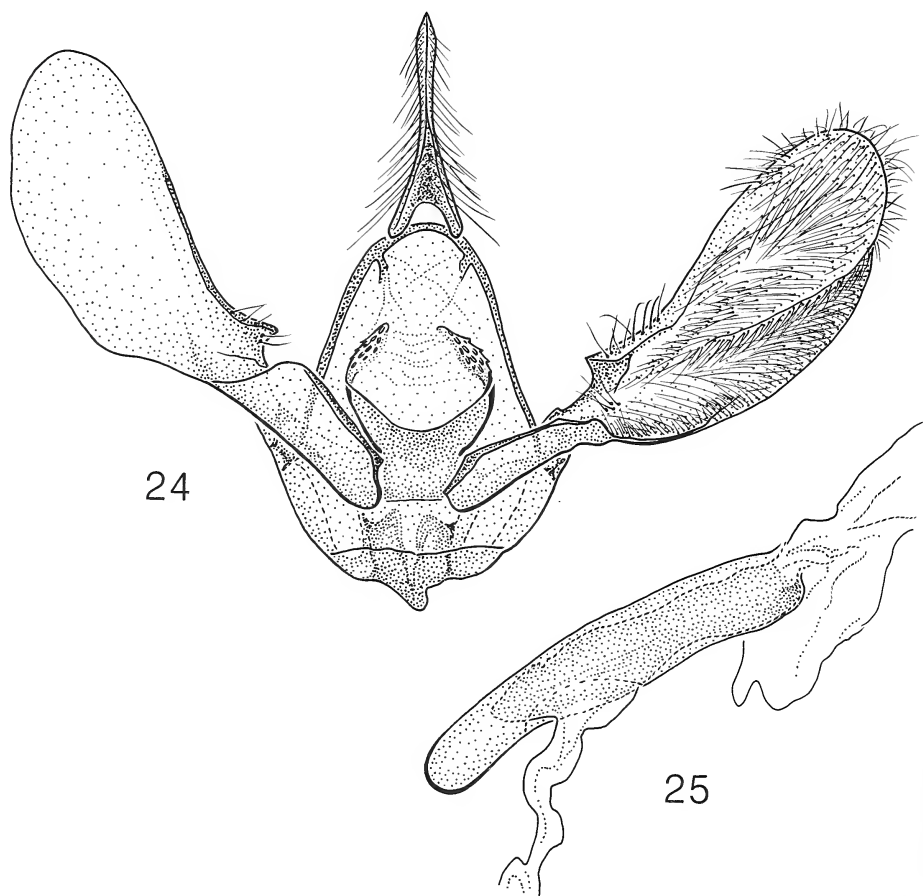
Ambia albibasalis Hampson, 1906:461; Munroe, 1995:44. NEW COMBINATION.

Diagnosis. Fore wing ground color white, all fasciae and lines pale brown, incomplete or absent. Hind wing with slight emargination near M_1 ; a dense, linear cluster of scales between CuA_2 and CuP ; scales with a very long base and spatulate apex, base white, apex brown. Costa of valva with a short dorsal projection about two-thirds length of valva. Outer margin of seventh sternum sclerotized except along median longitudinal axis; antrum timbal-shaped; accessory bursae originates from lateral part of corpus bursae.

Type. Holotype. ♂, Brazil, Sao Paulo (BMNH).



Figs. 20–23. 20. Male genitalia of *Lipocosma fonsecai*, USNM #107,922. 21. Aedeagus of *Lipocosma fonsecai*, USNM #107,922. 22. Male genitalia of *Lipocosma pitilla*, USNM #107,927. 23. Aedeagus of *Lipocosma pitilla*, USNM #107,927.



Figs. 24–25. 24. Male genitalia of *Lipocosma rosalia*, USNM #103,782. 25. Aedeagus of *Lipocosma rosalia*, USNM #103,782.

Material examined. Holotype not dissected. Other specimens examined: COSTA RICA: 1 ♀, Sirena, Corcovado Nat. Pk., Osa Peninsula, COSTA RICA, DH Janzen & W. Hallwachs, 13 Aug. 1980, COSTA RICA: INBIO: CRI1115193, genitalia slide USNM 107,943. 1 ♀, Est. Quebrada, Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Jun. 1991, COSTA RICA: INBIO: CRI348983. 1 ♀, Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Apr. 1991, COSTA RICA: INBIO: CRI288619. 1 ♂, same data as above except: Sept. 1991, COSTA RICA: INBIO: CRI357588. 1 ♂, same data as above except: Mar. 1991, COSTA RICA: INBIO: CRI365671. 1 ♀, Estac. Quebrada Bonita, Prov. Puntarenas, L-N-194500-469850, G. Varela, Aug. 1990, COSTA RICA: INBIO: CRI181020. 1 ♂, same data as above except: R. Zuniga, Apr. 1989, COSTA RICA: INBIO: CRI1111682. 2 ♀♀, 1 ♂, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, L-S-370900-449800, G. Varela & R. Zu-

niga, Dec. 1990, COSTA RICA: INBIO: CRI228714, CRI229263, CRI229085. 2 ♂♂, P.N. Manuel Antonio, 140m, Quepos, Prov. Puntarenas, L-S-371500-449450, G. Varela & R. Zuniga, Oct. 1990, COSTA RICA: INBIO: CRI222994, CRI223170. 1 ♀, P.N. Manuel Antonio, 80m, Quepos, Prov. Puntarenas, L-S-370900-448800, R. Zuniga, Feb. 1991, COSTA RICA: INBIO: CRI347182. 2 ♂♂, same data as above except: COSTA RICA: INBIO: CRI346901, CRI346906. VENEZUELA: 1 ♂, Caracas; BRAZIL: 1 ♂, Sao Paulo.

Distribution. Costa Rica south to coastal Brazil.

Lipocosma ausonialis (Druce)

Figs. 58–59

Glaphyria (?) *ausonialis* Druce, 1899:561; Klima, 1939:10. NEW COMBINATION.
Lipocosmia plagalis Schaus, 1912a:290. NEW SYNONYMY.

Diagnosis. Fore wing with posterior third of medial fascia dark brown, forming a rectangular spot. Hind wing with a linear cluster of scales between CuA_2 and CuP , each scale with a very long base and spatulate apex. Pseudognathos present; costa of valva sclerotized with apex spinelike; apical third of costa with small, heavily sclerotized spines; aedeagus with a knoblike protrusion $\frac{2}{3}$ distance from ductus ejaculatorius. Female with seventh sternum semicircular, with fold within intersegmental membrane; corpus bursae with a linear sclerotization near signum; medial part of corpus bursae with long pleated sclerotizations.

Types. *G. ausonialis*, holotype, ♀, Las Mercedes, Guatemala, genitalia slide USNM 108,042 [green label] (BMNH). *L. plagalis*, holotype, ♀, Juan Vinas, C[osta] R[ica], genitalia slide USNM 107,893 [green label], Type No. 17545 [red label] (USNM).

Material examined. Holotypes dissected. Other specimens examined: MEXICO: 1 ♀, Coatepec (abdomen glued to label). 1 ♀, Tehuacan; GUATEMALA: 1 ♂, 1 ♀, Volcan Sta. Maria. COSTA RICA: 1 ♀, (abdomen missing), 1 ♀, Juan Vinas [Cartago Prov.]. 1, sex unknown (abdomen missing), Carillo.

Distribution. Guatemala south to central Costa Rica.

Lipocosma calla (Kaye)

Figs. 5–6, 60

Neurophyseta calla Kaye, 1901:153.

Homophysa calla Kaye, 1901; Dyar, 1914:256. NEW COMBINATION.

Glaphyria calla Kaye, 1901; Klima, 1939:10. NEW COMBINATION.

Lipocosma calla Kaye, 1901; Munroe, 1964:1302. NEW COMBINATION.

Diagnosis. Fore wing and hind wing mostly pale yellow to yellow-orange; wing lines pale brown, incomplete or absent. Hind wing with a dense linear cluster of scales between CuA_2 and CuP , bases linear and white, apices spatulate and yellow. Costa of valva with two apical spines, both on a common linear stalk, another spine near base of apical stalk; aedeagus distally curved. Posterior margin of seventh sternum deeply emarginate.

Type. *N. calla*, holotype, ♂, Trinidad (BMNH).

Material examined. Holotype not dissected. Other material examined: MEXICO: 1

♀, Santa Rosa. 1 ♀, Panuco; GUATEMALA: 1 ♂, 1 ♀, Cayuga; COSTA RICA: 1 ♂, Cerro Tortuguero, 0–120m, P.N. Tortuguero, Prov. Limon, L-N-285000-588000, J. Solano, Mar. 1991, COSTA RICA: INBIO: CRI358848. 1 ♂, Est. Bijagual, 5000m, Res. Biol. Carara, Prov. Puntarenas, L-N-192250-474760, R. Zuniga, Sept. 1990, COSTA RICA: INBIO: CRI299461. 1 ♀, Est. Magsasay, 200m, P.N. Braulio Carrillo, L-N-264600-531000, R. Aguilar, Sept. 1990, COSTA RICA: INBIO: CRI484434. 1 ♀, Est. Pitilla, 700m, 9km S Sta. Cecilia, P.N. Guanacaste, Prov. Guanacaste, L-N-330200-380200, C. Moraga, 5/2/92–5/15/92, COSTA RICA: INBIO: CRI405663. 2 ♂♂, same data as above except: P. Rios, Jun. 1991, COSTA RICA: INBIO: CRI315380, CRI346788. 2 ♂♂ same data as above except: C. Moraga, 5/2/92–5/15/92, COSTA RICA: INBIO: CRI405670, CRI405668. 1 ♂, same data as above except: 27 Jul.–14 Aug. 1992, COSTA RICA: INBIO: CRI393805. 1 ♂, same data as above except: P. Rios, 6/1/91–6/30/91, COSTA RICA: INBIO: CRI315380. 3 ♀♀, Est. Quebrada Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Aug. 1990, COSTA RICA: INBIO: CRI181141, CRI181090, CRI181003. 1 ♂, 7 ♀♀, Est. Sirena, 0–100m, Puntarenas, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Apr. 1991, COSTA RICA: INBIO: CRI288719, CRI475945, CRI475945, CRI288659, CRI288716, CRI288735, CRI288742, CRI288744. 1 ♀, same data as above except: Mar. 1991, COSTA RICA: INBIO: CRI365453. 1 ♀, same data as above except: Sept. 1991, COSTA RICA: INBIO: CRI357527. 1 ♀, same data as above except: Oct. 1991, COSTA RICA: INBIO: CRI348319. 1 ♀, same data as above except: COSTA RICA: INBIO: CRI351694. 1 ♀, same data as above except: Dec. 1991, COSTA RICA: INBIO: CRI381078. 1 ♂, same data as above except: Jul. 1991, COSTA RICA: INBIO: CRI334897. 2 ♂, Estac. Quebrada Bonita, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Sept. 1989, COSTA RICA: INBIO: CRI1103074, CRI1055202. 1 ♂, 1 ♀, Fca. San Gabriel, 2km SW Dos Rios, Prov. Alajuela, L-N-318800-383500, GNP Biodiv. Survey, COSTA RICA: INBIO: CRI478, CRI216. 1 ♀, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, L-S-370900-449800, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI228089. 1 ♂, same data as above except: Dec. 1990, COSTA RICA: INBIO: CRI228855. 1 ♂, 1 ♀, same data as above except: 140m, G. Varela & R. Zuniga, Oct. 1990, COSTA RICA: INBIO: CRI223127, CRI223245. 1 ♀, same data as above except: L-S-370900-448800, 80m, R. Zuniga, Jan. 1991, COSTA RICA: INBIO: CRI366935. 1 ♂, Rancho Quemado, 200m, Peninsula de Osa, Prov. Puntarenas, L-S-292500-511000, F. Quesada, Dec. 1990, COSTA RICA: INBIO: CRI342754. 1 ♀, Sector Cerro Cocori, Fca. de E. Rojas, Prov. Limon, L-N-286000-567500, E. Rojas, Jan. 1992, COSTA RICA: INBIO: CRI332861. 1 ♀, same data as above except: Apr. 1991, COSTA RICA: INBIO: CRI452302. 1 ♀, same data as above except: Nov. 1991, COSTA RICA: INBIO: CRI460094. 1 ♂, Est. Pitilla, 700m, 9km S Sta. Cecilia, P.N. Guanacaste, Prov. Guanacaste, L-N-330200-380200, P. Rios, Jun. 1991, COSTA RICA: INBIO: CRI315169. 1 ♀, Finca La Selva (OTS), Puerto Viejo de Sarapiquí, Prov. Heredia, 50m, COSTA RICA, DH Janzen & W. Hallwachs, Nov. 1982, COSTA RICA: INBIO: CRI1115217. 1 ♂, same data as above except: 6–9 Mar. 1985, COSTA RICA: INBIO: CRI1115194, genitalia slide USNM 103,670. 1 ♂, 1 ♀, Finca San Gabriel, 630m, 16km E Quebrada Grande, Prov. Alajuela, COSTA RICA, DH Janzen & W. Hallwachs, 12 Mar. 1983, COSTA RICA: INBIO: CRI1115196, CRI1115195, gen-

italia slide USNM 103,671. 2 ♂♂, Fca. San Gabriel, 2km SW Dos Rios, Prov. Alajuela, L-N-318800-383500, COSTA RICA, 600m, GPN Biodiv. Survey, May 1989, COSTA RICA: INBIO: CRI737, CRI648. 2 ♂♂, Est. Sirena, P.N. Corcovado, 0–100m, Prov. Puntarenas, L-S-270500-508300, COSTA RICA, G. Fonseca, Oct. 1990, COSTA RICA: INBIO: CRI179062, CRI179193. 1 ♀, same data as above except: Dec. 1990, COSTA RICA: INBIO: CRI297343. 1 ♂, Cerro Tortuguero, P.N. Tortuguero, 0–100m, Prov. Limon, L-N-285000-588000, COSTA RICA, J. Solano, Mar. 1991, COSTA RICA: INBIO: CRI197597. 1 ♀, same data as above except: 100m, R. Aguilar & J. Solano, Apr. 1989, COSTA RICA: INBIO: CRI103080. 1 ♂, 120m, P.N. Manuel Antonio, Prov. Puntarenas, L-S-370900-449800, COSTA RICA, G. Varela & R. Zuniga, Dec. 1990, COSTA RICA: INBIO: CRI229162. 1 ♂, same data as above except: L-S-371500-449450, 140m, Oct. 1990, COSTA RICA: INBIO: CRI222874. 1 ♂, 1 ♀, Sector Cerro Cocori, Fca. de E Rojas, Prov. Limon, L-N-286000-567500, COSTA RICA, E. Rojas, Mar. 1991, COSTA RICA: INBIO: CRI181529, CRI181517. 1 ♂, same data as above except: 150m, Mar. 1992, COSTA RICA: INBIO: CRI364106, CRI363325, genitalia slide USNM 107,944. 1 ♀, Estac. Bijagual, 500m, Res. Biol. Carara, Prov. San Jose, L-N-192250-474760, R. Zuniga, Dec. 1989, COSTA RICA: INBIO: CRI1456, 1 ♀, Est. Magsasay, P.N. Braulio Carrillo, 200m, Prov. Heredia, L-N-264600-531100, R. Aguilar, Sept. 1990, COSTA RICA: INBIO: CRI484434. 1 ♀, same data as above except: M. Zumbado, Oct. 1990, COSTA RICA: INBIO: CRI180694. 1 ♂, Estac. Quebrada Bonita, 50m, R.B. Carara, Prov. Puntarenas, L-N-194500-469850, COSTA RICA, R. Zuniga, Aug. 1989, COSTA RICA: INBIO: CRI109566. 1 ♂, Est. Maritza, 600m, Lado oeste del Volcan Orosi, Prov. Guanacaste, L-N-326900-373000, I Curso Microlepidoptera, Jul. 1990, COSTA RICA: INBIO: CRI179522. 1 ♂, Est. Pitilla, 700m, 9km S Sta. Cecilia, P.N. Guanacaste, Prov. Guanacaste, L-N-330200-380200, COSTA RICA, C. Moraga, 2–15 May 1992, COSTA RICA: INBIO: CRI405670. 1 ♀, Est. Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, Nov. 1989, COSTA RICA: INBIO: CRI139646. 1 ♀, Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Jul. 1991, COSTA RICA: INBIO: CRI334851. 1 ♀, Turrialba; PANAMA: 1 ♂, Porto Bello; 2 ♀♀, Rio Trinidad; FRENCH GUIANA: 1 ♂, 5 ♀♀, Cayenne.

Distribution. Southern Mexico south through Central America to northern South America.

Lipocosma fonsecai, new species

Figs. 20–21, 33, 61

Diagnosis. Fore wing falcate; hind wing with a brown spot in cell. Valva broadly rounded apically; lower margin of valva produced into a single spine; vinculum V-shaped. Corpus bursae with two signa, each with several long spines.

Description. Head: Vertex and frontoclypeus mostly white, intermixed with brown scales; a tuft of brown scales near antennal bases along inner margin. Antennal scape white, flagellum white or pale brown. Ocellus absent. Outer surface of articles of maxillary palpus white basally, apically brown; inner surface white. Labial palpus similarly scaled. Proboscis pale brown, intermixed with white scales basally.

Thorax: Tegula mostly white basally with white scales tipped with brown or pale

brown scales apically. Anterior mesonotum with pale brown scales tipped with brown distally, white posteriorly. Inner surfaces of most segments and tarsomeres of thoracic legs basally pale yellowish-brown or yellowish-brown, distally white; outer surfaces white. Fore wing length = 6.4–6.7 mm (N = 5). Basal fascia mostly white, intermixed with brown scales. Antemedial, medial, and subterminal fasciae yellowish-brown, their associated lines white. Marginal line yellowish-brown. Fringe scales yellowish-brown, with mostly white marginal scales toward falcate apex. Under surface similarly patterned, but darker, or veins streaked yellowish-brown with inter-neural areas with brown scales intermixed with yellowish-brown and white scales. Area along posterior margin with white scales in some specimens. Hind wing with both surfaces similarly patterned as fore wing, but with a brown spot in discal cell. Area between CuA₂ and CuP with white piliform scales.

Abdomen: Upper surface mostly white, intermixed with white scales tipped with brown. Under surface white.

Male genitalia: Uncus slightly constricted near middle. Pseudognathos with a dorsomedial projection and apical area spinose. Vinculum v-shaped. Costa of valva not greatly sclerotized. Valva broadly rounded. Ventral margin of valva produced into a single spine. Posterior margin of juxta laterally expanded into a narrow projection.

Female genitalia: Ductus bursae posteriorly membranous, anteriorly sclerotized. Corpus bursae with two circular signa, each with several long spines. A ringlike sclerite located posterior to signa.

Types. Holotype: ♀, Est.[acion] Sirena, P.N. Corcovado, 0–100m, Prov.[incia] Punt.[arenas], COSTA RICA, G. Fonseca, Mar[ch] 1991, L-S-270500.508300, COSTA RICA: INBIO: CRI365650 [not dissected] (INBIO). Paratypes: 1 ♂, F[in]ca Cafrosa, Est.[acion] Las Mellizas, P.N. Amistad, Puntarenas Pr.[ovincia], COSTA RICA, 1300m, Novem[ber], 1989, M. Ramirez & G. Mora, L-N-316100.596100, COSTA RICA: INBIO: CRI156955, genitalia slide USNM 107,922. 1 ♀, F[in]ca San Gabriel 2km SW, Dos Rios, 600m, Prov.[incia] Alaj[uela], COSTA RICA, 1 Curso, Microlepidop.[tera], Jul[y] 1990, 318800.383500, COSTA RICA: INBIO: CRI181994, genitalia slide USNM 107,923; 1 ♀, F[in]ca Cafrosa, Est.[acion] Las Mellizas, P.N. Amistad, 1300m, Prov.[incia] Punt.[arenas], COSTA RICA, M. Ramirez, & G. Mora, Oct[ober] 1990, L-S-316100.596100, COSTA RICA: INBIO: CRI1109059. 1 ♀, Est.[acion] Sirena, P.N. Corcovado, 0–100m, Prov.[incia] Punt.[arenas], COSTA RICA, G. Fonseca, L-S-270500.508300, COSTA RICA: INBIO: CRI183300.

Distribution: Costa Rica.

Etymology. The specific epithet honors the collector of the holotype and various paratypes: Mr. Gilberto Fonseca.

Lipocosma furvalis (Hampson)

Fig. 62

Homophysa furvalis Hampson, 1912:156; Munroe, 1995:44.

Diagnosis. Fore wing brownish-orange distally, grading to pale brownish-orange basally. Antemedial, postmedial, and submarginal lines faint, demarcated by faint white scales laterally. Hind wing area between CuA₂ and CuP without piliform or

spatulate scales. Pseudognathos present; costa of valva developed into a spine projecting inward to near tegumen; vesica cornutus with several spine, largest spine nearly equal length of aedeagus. Corpus bursae with spinose anterior and posterior ends, membranous medially; ductus bursae sclerotized entire length. Ductus seminalis sclerotized basally.

Type. Holotype, ♀, Mexico, genitalia slide USNM 108,041 [green label] (BMNH).

Material examined. Holotype dissected. Other specimens examined: GUATEMALA: 1 ♀, Cayuga; COSTA RICA: 1 ♂, Tuis; BARBADOS: 1 ♀.

Distribution. Mexico south to Costa Rica and the Lesser Antilles.

Lipocosma nigripictalis Hampson

Fig. 63

Lipocosma nigripictalis Hampson, 1898:612.

Diagnosis. Fore wing with basal fascia white, remaining wing area pale brownish-orange; lines pale brown, incomplete or absent; a small spot in tornal area. Hind wing mostly light brown, a small spot near wing margin in anal area; a linear cluster of scales between CuA₂ and CuP, each scale with white linear base and brown spatulate apex. Pseudognathos present; costa of valva apically recurved; outer margin of valva broadly rounded, uncus slightly hooked ventrally. A spiralled, bandlike sclerotization from anterior end of ductus bursae to posterior part of corpus bursae to ductus seminalis; midsection of corpus bursae with peglike spines with stellate bases, anterior portion of corpus bursae membranous.

Type. Holotype, ♂, Espiritu Santo, Brazil (BMNH).

Material examined. Holotype, not dissected. Other specimens examined: MEXICO: 1 ♀, Orizaba; COSTA RICA: 1 ♀, Estac. Quebrada Bonita, 50m, R.B. Carara, Prov. Puntarenas, L-N-194500-469850, COSTA RICA, R. Zuniga, Sept. 1989, COSTA RICA: INBIO: CRI1103082, genitalia slide USNM 107,954. 1 ♀, 4km E Casetilla, Rincon Nat. Pk. Prov. Guanacaste, COSTA RICA, DH Janzen & W. Hallwachs, 6 Jun. 1981, COSTA RICA: INBIO: CRI1115197. 1 ♂, Fca. Cafrosa, 1300m, Est. Las Mellizas, P. Inter. La Amistad, Prov. Puntarenas, L-S-316100-596100, M.M. Charria & G. Mora, Jan. 1991, COSTA RICA: INBIO: CRI380701. 1 ♀, Quebrada Segunda, P.N. Tapanti, 1250m, Prov. Cartago, L-N-194000-559800, G. Mora, Oct. 1991, COSTA RICA: INBIO: CRI441487. 1 ♂, Sector Cerro Cocori, Fca. de E Rojas, 150m, Prov. Limon, L-N-286000-567500, E. Rojas, Mar. 1992, COSTA RICA: INBIO: CRI363692. 2 ♂♂, 2 ♀♀, Turrialba; ECUADOR: 1 ♂, Quevedo; VENEUELA: 1 ♀, Rancho Grande.

Distribution. Southern Mexico south to Brazil.

Lipocosma pitilla, new species

Figs. 22–23, 34, 64

Diagnosis. Fore wing with a small brown subcostal spot between subterminal and postmedial lines. Uncus with a medial triangular projection; ventral margin of valva produced into a short recurved spine. Female with two ventrolateral arms in intersegmental membrane between segments seven and eight; ostium bursae ventrally

emarginate; ductus bursae with a ringlike sclerotization posterior to ductus seminalis; signum small and globular.

Description. Head: Head and its appendages white, except for a basolateral dark spot on the terminal article of the maxillary palpus. Ocellus absent. Proboscis with basal white scales.

Thorax: Tegula and mesonotum white, except for some brown near base of fore wing. All thoracic legs white, except in one specimen with inner surface of tibia pale brown. Fore wing length = 6.8–7.4 mm (N = 4). Ground color white; postmedial and subterminal lines brown, antemedial lines pale brown or absent; a small brown subcostal spot between subterminal and postmedial lines. The holotype has a wide pale brown diagonal streak from subcostal spot to tornus. Inner fringe scales with basal half white, distal half pale brown; outer fringe scales mostly white intermixed with pale brown scales. Under surface as above, but paler. Hind wing with lines pale brown, areas between lines mostly white intermixed with pale brown scales. Under surface as above, but paler. Area between CuA_2 and CuP without piliform or spatulate scales.

Abdomen: Mostly white intermixed with pale brown scales.

Male genitalia: Uncus with a broadly rounded apex. Uncus lateral arms ventromedially with an elongate subtriangular projection; pseudognathos abruptly terminates into two broad lateral arms. Vinculum broad. Costa of valva broadly extending medially, sclerotized and curved, and terminating as a small anteriorly reflexed hook, possibly attached to anellus. Costa slightly dilated dorsally near the apical ridge. Saccus setose with lower margin of valva produced into a short recurved spine. Median part of valva with short setae, apically with longer hairlike setae. Juxta subtrapezoidal basally with an elongate dorsal process. Aedeagus narrow, cornutus absent.

Female genitalia: Sterigma with two narrow lateral arms that broadly extend ventrolaterally and converge beyond ostium bursae, but do not fuse; ostium bursae deeply emarginate ventrally. Setose area posterior to dorsal margin of ostium bursae. Ductus bursae membranous throughout. A small ringlike structure posterior and proximal to inception of ductus seminalis. Corpus bursae membranous; signum small and globular.

Types. Holotype: ♂, Est.[acion] Pitilla, 700m, 9km S[outh], S[an]ta Cecilia, P.N. Guana.[caste] Prov.[incia] Guan.[acaste], COSTA RICA, C. Mora, Ago 1991, L-N-330200, 380200, COSTA RICA: INBIO: CRI537816 [not dissected] (INBIO). Paratypes: 1 ♂, Estac.[ion] Pitilla, 700m, 9km S[outh], Santa Cecilia, Guanac.[aste] Pr.[ovincia], COSTA RICA. May 1989, GNP Biodiversity Survey, 330200, 380200, COSTA RICA: INBIO: CRI9229, genitalia slide USNM 107,927. 1 ♀, same data as holotype except: COSTA RICA: INBIO: CRI9153, genitalia slide USNM 107,928. 1 ♂, same data as holotype except: COSTA RICA: INBIO: CRI9236 [not dissected]. 1 ♀, Estac. Bijagual, 500m, Res. Biol. Carara, Prov. San Jose, COSTA RICA, Nov. 1989, R. Zuniga, L-N-192250-474760. All paratypes in USNM.

Distribution: Costa Rica.

Etymology. The specific epithet is based on the name of the locality of the holotype and paratypes, Estacion Pitilla.

***Lipocosma rosalia*, new species**

Figs. 10–11, 24–25, 35

Diagnosis. A large costal process near base of male valva and female signum with three flat arms, each with a single row of spines.

Description. Head: Vertex and frontoclypeus uniformly lustrous white (hereinafter referred to as white), some specimens mostly white intermixed with pale grayish-yellow scales. Antenna white. Ocellus present. Maxillary palpus and inner surface of labial palpus white, outer surface white, except for pale grayish-yellow scales intermixed with brown scales near apical area of segment one, and pale grayish-yellow scales near apical area of segment two. Proboscis with basal white scales.

Thorax: Tegula and mesonotum grayish-brown, inner margin white. Anterior half of mesoscutum grayish-yellow, posterior half white. Prothoracic legs white, or white with outer surface of femur and tibia intermixed with grayish-yellow scales apically; tarsomeres white, or basal tarsomeres grayish-brown; distal tarsomeres white. Outer surfaces of pterothoracic legs white; inner surface of mesothoracic femur and tibia white, or mostly white with grayish-yellow, or grayish-yellow scales intermixed with pale brown and brown scales near apex; tarsomeres white, or mostly white with grayish-yellow scales near apex. Inner surface of metathoracic leg as above. Fore wing length = 4.8–6.5 mm (N = 10); slightly falcate. Ground color lustrous white. Submarginal, postmedial, antemedial lines, and basal patch yellow, golden yellow at different angles; discal spot brown. An irregular brownish pattern between the submarginal and subterminal lines, and subterminal and antemedial lines. Area between wing margin and submarginal line grayish-yellow. Fringe scales grayish-yellow tipped with brown. Under surface as above, but paler. R_3 and R_4 stalked distally (Fig. 11). M_1 closer to R_5 than to M_2 . Cubitus 4-branched. $1A+2A$ prominent. $3A$ faint. Male retinaculum hook from base of Sc. Hind wing with ground color white. Submarginal and postmedial lines, discal spot (white in center), wing margin and fringe as above. An irregular grayish-yellow pattern between submarginal and postmedial lines. Grayish-yellow scales demarcate lower half of discal spot, extending to postmedial line. Area between CuA_2 and CuP with spatulate scales, forming a tuft; scales with pale brown or white elongate bases, tipped with brown. Under surface as above, but paler. Outer margin expanded between $Sc+R_1$ and M_1 , forming a rounded apex at Rs . $Sc+R_1$ separate along length of cell, uniting just beyond cell. Cubitus 4-branched. Male with $1A$ distally only two-thirds length of wing; $2A$ complete; $3A$ only present halfway to margin of wing. Female with $1A$ absent and $2A$ and $3A$ complete. Three acanthae fused along entire length of frenulum to form one bristle in males; acanthae diverge subapically, three bristles separate in females.

Abdomen: Upperside pattern same as underside, except terminal segments, which are uniform grayish-yellow. First tergum white, other terga (except terminal segments) grayish-yellow anteriorly, white posteriorly. Under surface mostly white intermixed with grayish-yellow scales.

Male genitalia: Uncus narrowed gradually from basal arms to near midlength, posterior surface keeled on distal half. Tegumen thin. Pseudognathos two very short lateral arms. Vinculum with a slightly protuberant saccus. Saccus extends dorsolaterally fusing with dorsal part of vinculum and ventral part of tegumen. Valva with costa heavily sclerotized; a large costal process articulates with vinculum; valva

membranous. Inner surface of valva setose, outer surface less setose, with sparsely distributed scale sockets. Lateral arms of juxta curve dorsally, forming an open circlelike structure, distal portion of each arm with slightly raised triangular projections. Aedeagus moderately heavily sclerotized throughout length. Cornutus absent.

Female genitalia: Papillae anales laterally flattened. Ostium bursae within membrane overlaid by posterior portion of seventh sternum. Seventh tergum extends beyond posterior margin of seventh sternum, with short posterolateral arms produced ventrally. Antrum sclerotized, developed into a protuberant rim posteriorly, slightly narrowed anteriorly. Ductus bursae short. Signum with three flattened arms, two extending anteriorly from base of ductus bursae, on ventral surface of corpus bursae, and one on dorsal surface of corpus bursae at same level as other two. Each arm with free ends broadly rounded and demarcated by a single row of elongated spines. Ductus seminalis from posterior end of corpus bursae; spiralled, wide at base, narrowed distally.

Types. Holotype: ♂, Santa Rosa National Park, Guanacaste Provincia, COSTA RICA, 23–25 Jun[e] 1980, D. H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109306, genitalia slide USNM 103782, [green label] (INBIO). Paratypes: 1 ♀, Santa Rosa National Park; Guana.[caste] Prov.[incia], Costa Rica; 4–6 July 1979, D. H. Janzen, COSTA RICA: INBIO: CRI1109308. 1 ♀, Santa Rosa National Park; Guanacaste Prov.[incia], COSTA RICA, 13–15 Jul[y] 1980; D. H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109307. 1 ♀, Santa Rosa National Park; Guanacaste Prov.[incia], COSTA RICA, 7–9 Jul[y] 1980; D. H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109309, genitalia slide USNM 105,821 [green label]. 1 ♀, Santa Rosa National Park, Guanacaste Prov.[incia], COSTA RICA, 12–14 May 1980; D. H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109310. 1 ♀, Santa Rosa National Park, Guana.[caste] Prov.[incia], Costa Rica, 22–24 Jun[e] 1979, D. H. Janzen, COSTA RICA: INBIO: CRI1109312. 1 ♀, 4km. W.[est] Sta.[tion] Cecilla, Guanacaste Prov.[incia] COSTA RICA, 17 April 1983, 300m; D. H. Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI1109311. 1 ♀, P.N. Barra Honda, 3km NW Nacaome, Guanac.[aste] Prov.[incia], COSTA RICA, 100m, Janzen & Hallwachs, 6 Jan. 1989, COSTA RICA: INBIO: CRI103096.

Other specimens examined. MEXICO: 1 ♂, La Gloria, Cardel, VC [Veracruz]; Mex[ico] I-1938, J. Camelo; No. 3518, wing slide USNM 106,423. COLOMBIA: 1 ♂, Atlantico, Cuatro Bocas, 21-I-1959, J. F. G. Clarke, wing slide USNM 106,422; 1 ♂, Atlantico, 200m, Cuatro Bocas, J. F. G. Clarke.

Distribution. Mexico south to northern South America.

Etymology. The specific epithet is derived from the type locality of Santa Rosa National Park.

Parambia Dyar

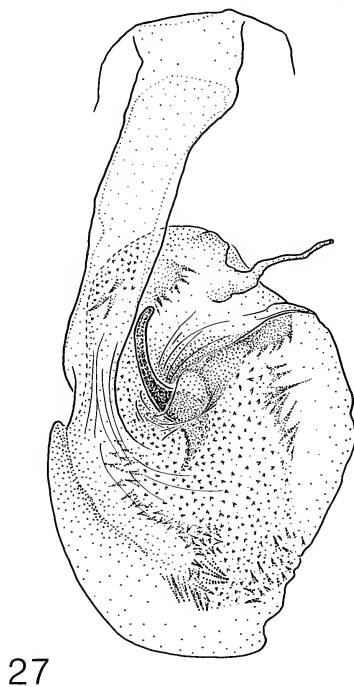
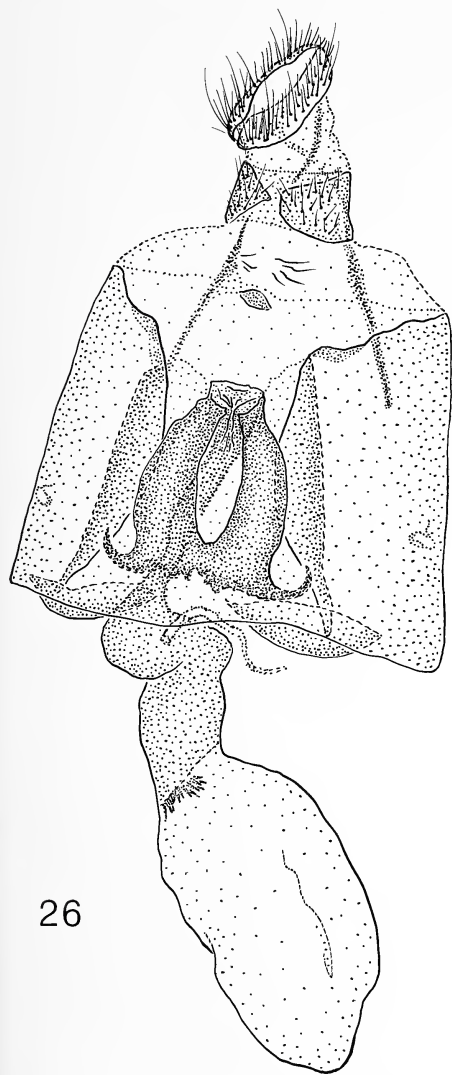
This genus has 4 species. No biological information is available.

Parambia gnomosynalis Dyar

Fig. 66

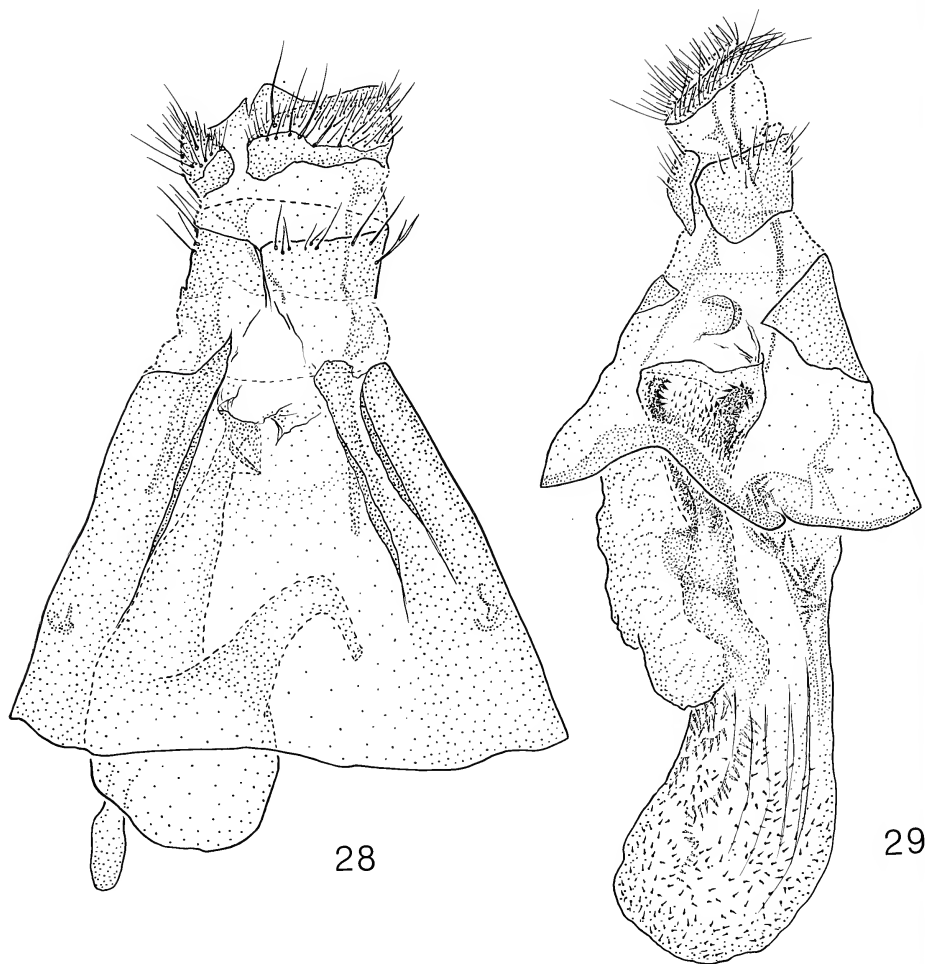
Parambia gnomosynalis Dyar, 1914:292.

Parambia glenealis Dyar, 1914:292. **NEW SYNONYMY.**



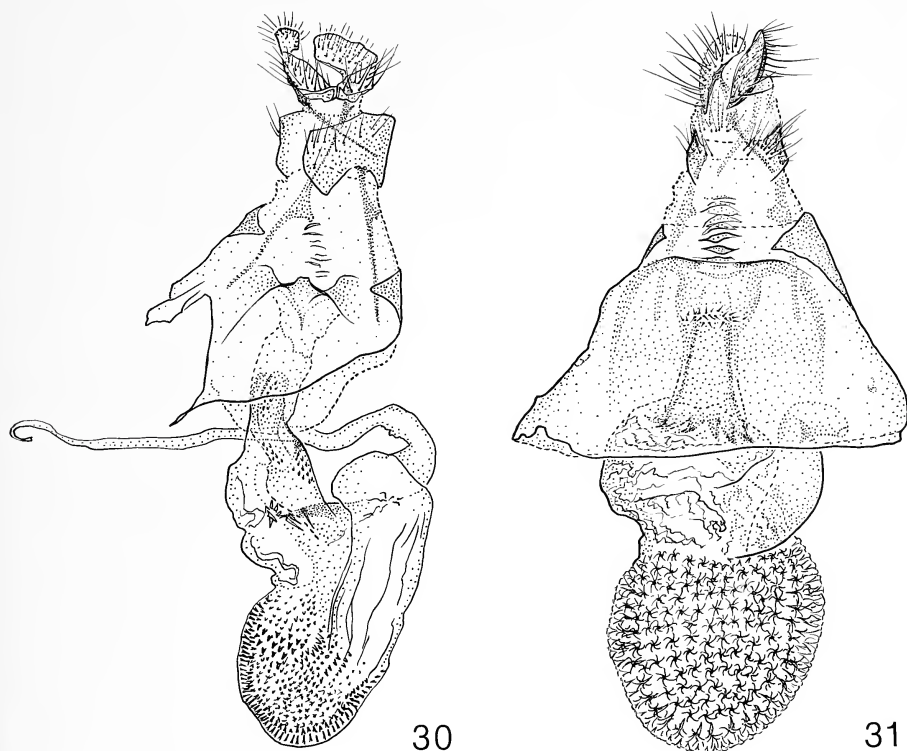
Figs. 26–27. 26. Female genitalia of *Aureopteryx olufsoni*, USNM #103,729. 27. Female genitalia of *Eupoca chicalis* Schaus, USNM #108,108.

Diagnosis. Fore wing with basal fascia white, other wing areas mostly brown. Thorax white. Hind wing mostly brown, subterminal line white; emarginate posterior to M_1 , linear cluster of scales between CuA_2 and CuP , each scale with a white linear base and brown spatulate apex. Costa of valva with one or two small spines at apex; uncus about half length of valva; corntus a row spines entire length of aedeagus. Female genitalia with an irregular row of linear spines within corpus bursae, anterior portion of corpus bursae membranous.



Figs. 28–29. 28. Female genitalia of *Eupoca haakei*, #USNM 107,894. 29. Female genitalia of *Glaphyria spinacrista*, USNM #107,919.

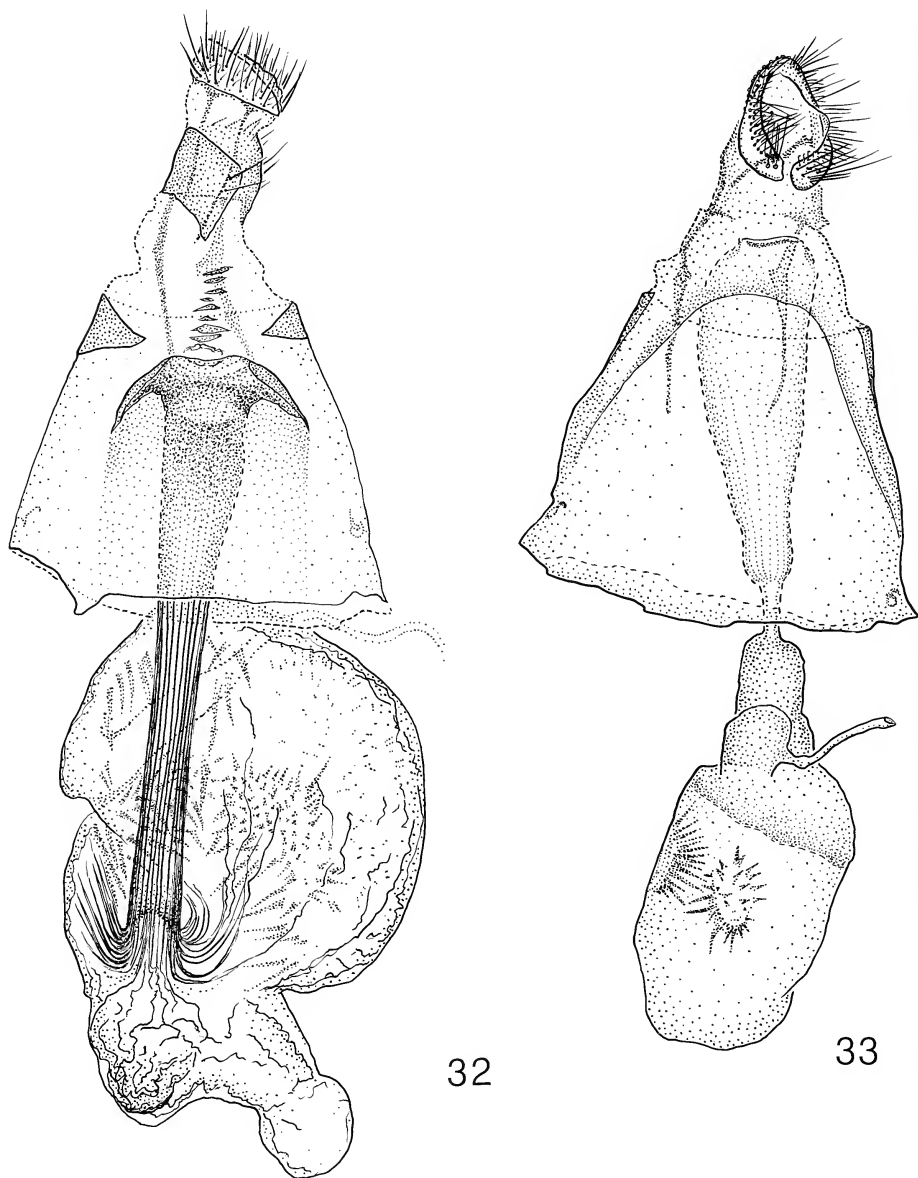
Types. *P. gnomosynalis*, holotype, ♀, Porto Bello, Panama, genitalia slide USNM 107,963 [green label]. *P. glenealis*, holotype, ♀, Corazal, C[anal] Z[one], Pan[ama], genitalia slide USNM 107,968 [green label], Type No. 16197 [red label] (USNM). **Material examined.** Holotypes dissected. Other specimens examined: GUATEMALA: 3 ♂♂, 4 ♀♀, Cayuga; COSTA RICA: 1 ♀, 9.4km W Bribri Suretka, 200m, Prov. Limon, COSTA RICA, DH Janzen & W. Hallwachs, 9–11 Jun. 1983, COSTA RICA: INBIO: CRI1115202. 2 ♂♂, 1 ♀, Est. Bijagual, 500m, Res. Biol. Carara, Prov. Puntarenas, L-N-192250-474760, COSTA RICA: INBIO: CRI296257, CRI296339, CRI299424. 1 ♀, same data as above except: Jan. 1991, COSTA RICA: INBIO: CRI452588. 1 ♂, Est. Quebrada, Bonita, 50m, Res. Biol. Carara, Prov. Puntarenas, L-N-194500-469850, R. Zuniga, COSTA RICA: INBIO: CRI349014. 1 ♂,



Figs. 30–31. 30. Female genitalia of *Glaphyria spinasingularis*, USNM #103,785. 31. Female genitalia of *Glaphyria stellaspina*, USNM #105,822.

Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Sept. 1991, COSTA RICA: INBIO: CRI357553. 1 ♂, P.N. Manuel Antonio, 140m, Quepos, Prov. Puntarenas, L-S-371500-449450, G. Varela & R. Zuniga, Oct. 1990, COSTA RICA: INBIO: CRI223326. 1 ♀, Rancho Quemado, 200m, Peninsula de Osa, Prov. Puntarenas, L-S-292500-511000, F. Quesada, Feb. 1992, COSTA RICA: INBIO: CRI345179. 1 ♀, Sector Cerro Cocori, Fca. de E Rojas, 150m, L-N-286000-567500, E. Rojas, Mar. 1991, COSTA RICA: INBIO: CRI181561. 1 ♀, same data as above except: Apr. 1991, COSTA RICA: INBIO: CRI452283. 2 ♀♀, 4km W Sta. Cecilia, Prov. Guanacaste, COSTA RICA, DH Janzen & W. Hallwachs, 3 Jun. 1981, COSTA RICA: INBIO: CRI1115201, CRI1115199, genitalia slide USNM 103,676. 1 ♀, same data as above except: 250m, 25 Feb. 1985, COSTA RICA: INBIO: CRI1115200. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, DH Janzen, 12 Dec. 1978–10 Jan. 1979, COSTA RICA: INBIO: CRI1115198. 1 ♂, W of Carmona Nicoya, Prov. Guanacaste, COSTA RICA, 600–700m, DH Janzen & W. Hallwachs, 19 Aug. 1982, COSTA RICA; INBIO: CRI381061, genitalia slide USNM 103,675. 1 ♂, 1 ♀, Turrialba; PANAMA: 1 ♂, Tabernilla (Canal Zone); FRENCH GUIANA: 2 ♂♂, 2 ♀♀, Cayenne.

Distribution. Guatemala south through Central America to northern South America.



Figs. 32-33. 32. Female genitalia of *Glaphyria tetraspina*, USNM #107,936. 33. Female genitalia of *Lipocosma fonsecai*, USNM #107,923.

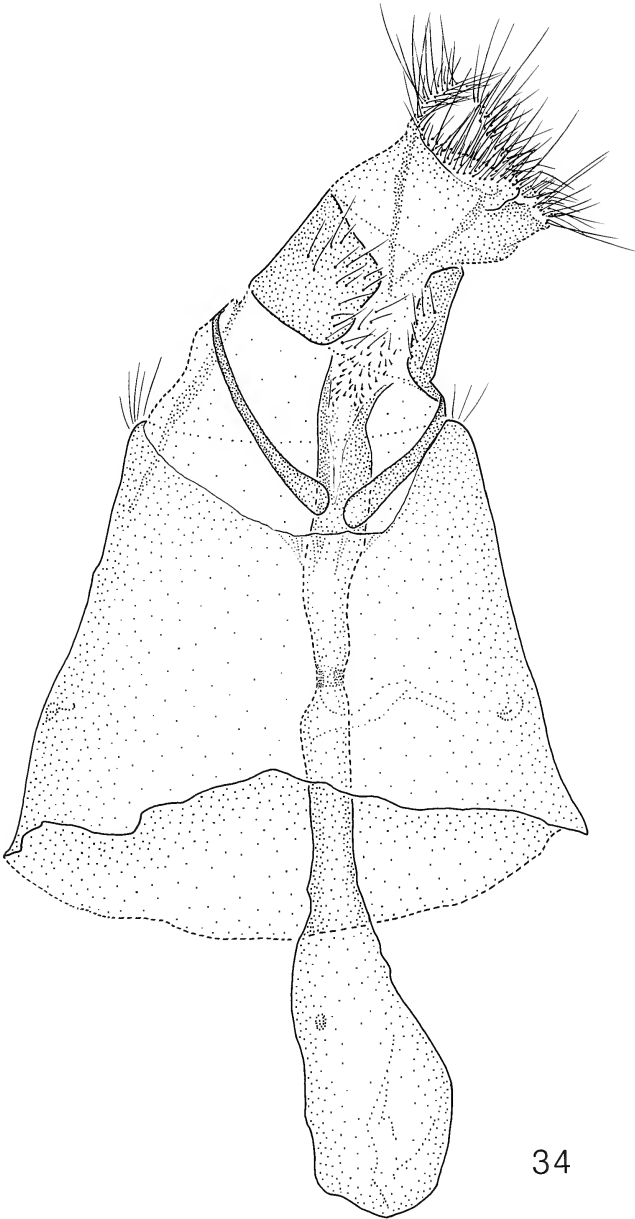


Fig. 34. Female genitalia of *Lipocosma pitilla*, USNM #107,928.

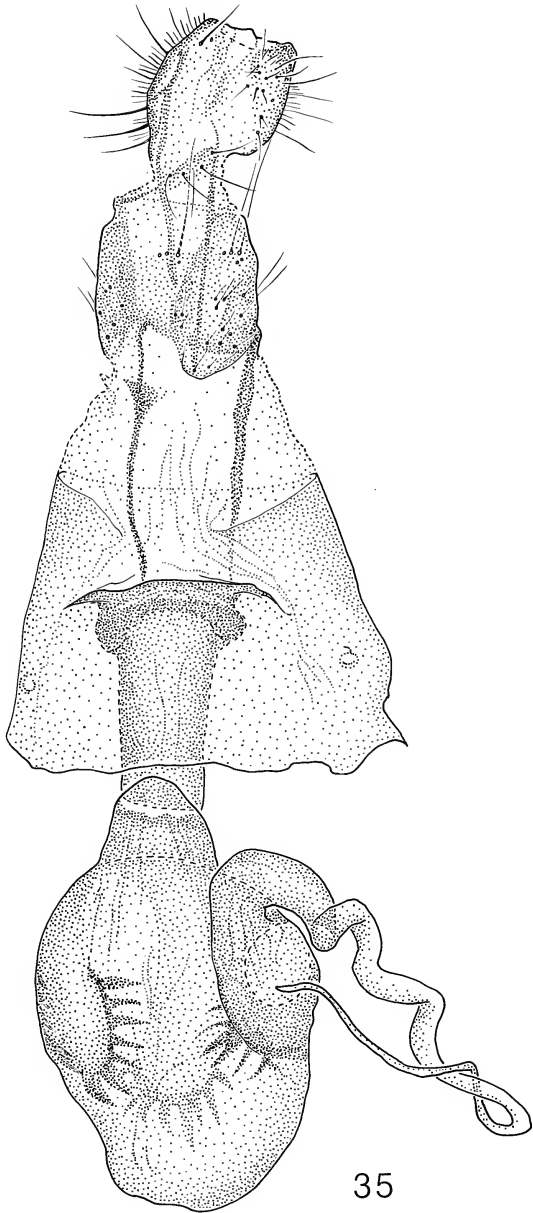


Fig. 35. Female genitalia of *Lipocosma rosalia*, USNM #105,821.

Pseudoliostigma Strand

This genus has 11 species. Three species occur in Costa Rica: *P. argyractalis* (Schaus), *P. enareralis* (Dyar), *P. punctissimalis* (Dyar). No biological information is available.

Pseudoliostigma argyractalis (Schaus)

Fig. 53

Ambia argyractalis Schaus, 1912b:676.

Heptalitha argyractalis Schaus, 1912b; Munroe, 1964:1298. NEW COMBINATION.

Pseudoliostigma argyractalis Schaus, 1912b; Munroe, 1995:44. NEW COMBINATION.

Diagnosis. Fore wing with a medial transverse brown streak from middle of wing to outer margin. Hind wing slightly emarginate beyond M_1 ; a dense cluster of black piliform setae between CuA_2 and CuP ; seven black marginal spots between M_2 and CuA_2 . Seventh sternum narrowly rounded posteriorly; ductus bursae with two linear sclerotizations near base, signum absent.

Type. Holotype, ♀, Juan Vinas, C[osta] R[ica], genitalia slide USNM 107,971 [green label], Type No. 17686 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: GUATEMALA: 1 ♀, Chejel. 1 ♀, Cayuga; COSTA RICA: 1 ♀, La Montura, Braulio Carillo Nat. Pk., Prov. San Jose, COSTA RICA, 1100m, DH Janzen & W. Hallwachs, 17 Dec. 1981, COSTA RICA: INBIO: CRI115163, genitalia slide USNM 103,787. 1 ♀, same data as above except: L-N-236700-541800, 12/17/81, COSTA RICA: INBIO: CRI115626.

Distribution. Western Guatemala south to central Costa Rica.

Remarks. Male unknown.

Pseudoliostigma enareralis (Dyar)

Fig. 54

Ambia enareralis Dyar, 1914:294. Munroe, 1964:1298. NEW COMBINATION.

Pseudoliostigma enareralis Dyar, 1914; Munroe, 1995:44. NEW COMBINATION.

Diagnosis. Hind wing with seven marginal spots between M_2 and CuP . Large semi-circular fold posterior to ostium bursae and a broad depression posterior to mentioned fold.

Type. Holotype, ♀, La Chorrera, Pan[ama], genitalia slide USNM 107,946 [green label], Type No. 16202 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: COSTA RICA: 1 ♀, Sirena, Corcovado Nat. Pk., Osa Peininsula, COSTA RICA, 1 May 1984, DH Janzen & W. Hallwachs, COSTA RICA: INBIO: CRI115164, genitalia slide USNM 103,788. 1 ♀, 2 km W sta. Cecilia, Prov. Guanacaste, L-N-338700-541800, DH Janzen, 12/25/84/, COSTA RICA: INBIO: CRI1106281. 1 ♀, Est. Bijagual, 500m, Res. Biol. Carara, Prov. Puntarenas, L-N-192250-474760, R. Zuniga, Sept. 1990, COSTA RICA: INBIO: CRI299598. 1 ♀, Est, Pitilla, 700m, 9 km S Sta. Cecilia, P.

N. Guanacaste, Prov. Guanacaste, L-N-330200-380200, C. Moraga & P. Rios, Dec. 1989, COSTA RICA: INBIO: CRI190648. 1 ♀, Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Apr. 1991, COSTA RICA: INBIO: CRI288713. 1 ♀, P.N. Manuel Antonio, 120m, Quepos, Prov. Puntarenas, L-S-370900-449800, G. Varela & R. Zuniga, Nov. 1990, COSTA RICA: INBIO: CRI218911. 1 ♀, same data as above except: COSTA RICA: INBIO: CRI218880. 1 ♀, Rancho Quemado, 200m, Peninsula de Osa, Prov. Puntarenas, L-S-292500-511000, F. Quesada, Dec. 1991, COSTA RICA: INBIO: CRI483313. 1 ♀, Sector Cerro Cocori, Fca. de E. Rojas, 150m, Prov. Limon, L-N-286000-567500, E. Rojas, Mar. 1991, COSTA RICA: INBIO: CRI181611. 1 ♀, same data as above except: May 1992, COSTA RICA: INBIO: CRI373516. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, DH Janzen, 4–6 Dec. 1979, COSTA RICA: INBIO: CRI1115166. 1 ♀, Est. Hiltoy-Cerere, Res. Biol. Hiltoy Cerere, Rio Cerere, 200m, Prov. Limon, L-N-184200-643300, COSTA RICA: M. Borrelier, Nov. 1990, COSTA RICA: INBIO: CRI384293. 1 ♀, Estac. Bijagual, 500m, Res. Biol. Carara, Prov. San Jose, L-N-192250-474760, COSTA RICA, R. Zuniga, Dec 1989, COSTA RICA: INBIO: CRI1617.

Distribution. Costa Rica south to central Panama.

Remarks. Male unknown.

Pseudoliosigma punctissimalis (Dyar)

Figs. 3–4, 55

Lipocosma punctissimalis Dyar, 1914:258.

Pseudoliosigma punctissimalis Dyar; Munroe, 1995:44. NEW COMBINATION.

Lipocosma teliferalis Dyar, 1914:258. NEW SYNONYMY.

Diagnosis. Fore wing with a large dark grayish-brown area proximal to subterminal line. Hind wing deeply emarginate posterior to M_1 ; seven black marginal spots between M_2 and CuP; several dark brown piliform scales overlaid by a small cluster of erect squamiform dark brown scales between CuA_2 and CuP. Valva with a recurved costal projection at base; juxta with two linear dorsal projections and a ventral support that bifurcates laterally; cornutus with several spines distally bifurcate. Posterior margin of seventh sternum slightly emarginate, anterior to spiracle; corpus bursae sclerotized near inception of ductus seminalis; signum absent.

Types. *L. punctissimalis*, holotype, ♂, Isl[and], Pan[ama], genitalia slide USNM 107,969 [green label], Type No. 16171 [red label] (USNM). *L. teliferalis*, holotype, ♂, Taboga Is., Pan[ama], genitalia slide USNM 107,950 [green label], Type No. 16172 [red label] (USNM).

Material examined. Holotypes dissected. Other specimens examined: COSTA RICA: 1 ♀, Fca. Jenny, 30km N de Liberia, P.N. Guanacaste, Prov. Guanacaste, L-N-316200-364400, R. Espinoza, Jul. 1991, COSTA RICA: INBIO: CRI332418. 1 ♀, Est. Sirena, 0–100m, P.N. Corcovado, Prov. Puntarenas, L-S-270500-508300, G. Fonseca, Nov. 1991, COSTA RICA: INBIO: CRI351784. 1 ♂, P.N. Manuel Antonio, 80m, Quepos, Prov. Puntarenas, L-S-370900-448800. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA, DH Janzen, 4–6 Dec. 1979, COSTA RICA: INBIO: CRI1115166. 1 ♀, Est. Hiltoy-Cerere, Res. Biol. Hiltoy Cerere, Rio Cerere,

200m, Prov. Limon, L-N-184200-643300, COSTA RICA: M. Borrelier, Nov. 1990, COSTA RICA: INBIO: CRI384293. 1 ♀, Estac. Bijagual, 500m, Res. Biol. Carara, Prov. San Jose, L-N-192250-474760, COSTA RICA, R. Zuniga, Dec 1989, COSTA RICA: INBIO: CRI1617. 1 ♀, Santa Rosa National Park, Prov. Guanacaste, COSTA RICA: DH Janzen, 12 Dec. 1978–10 Jan. 1979, COSTA RICA: INBIO: CRI115192, genitalia slide USNM 103,674. PANAMA: 1 ♀, Porto Bello. 3 ♂♂, 1 ♀, Taboga Is.; TRINIDAD: 1 ♀, Fyzabad.

Distribution. Northwestern Costa Rica south to Panama including Trinidad.

Stegae Munroe

This genus has 11 species; only one species, *S. hermalis* (Schaus) occurs in Costa Rica. No biological information is available.

Stegae hermalis (Schaus)

Fig. 67

Symphysa hermalis Schaus, 1920:176; Munroe, 1995:43. NEW SYNONYMY.

Diagnosis. Fore wing brown, lines faint. Hind wing usually darker in cubital and anal areas than fore wing. Hind wing area between CuA₂ and CuP with or without spatulate scales. Pseudognathos present; costa of valva with a recurved projection near base and one spine apically; vinculum highly sclerotized, elongated and bifurcate anteriorly; juxta with three stout spines. Posterior part of antrum as wide as seventh sternum; ductus bursae partially sclerotized longitudinally, anterior portion of corpus bursae with peglike spines with stellate bases, a deep, pouchlike structure between seventh sternum and spiracle.

Type. Holotype, ♀, Cayuga, Guat[emala], genitalia slide USNM 107,972 [green label], Type no. 23527 [red label] (USNM).

Material examined. Holotype dissected. Other specimens examined: MEXICO: 1 ♂, 6 ♀♀, La Gloria. 1 ♀, Orizaba. 1 ♀, Colima. 1 ♀, Tehuacan; GUATEMALA: 1 ♂, 5 ♀♀, Cayuga; COSTA RICA: 1 ♂, Finca La Selva (OTS), Puerto Viejo de Sarapiquí, 50m, Prov. Heredia, COSTA RICA, DH Janzen & W. Hallwachs, 6–9 Mar. 1985, COSTA RICA: INBIO: CRI115203, genitalia slide USNM 103,796. 1 ♂, Cerro Tortuguero, P.N. Tortuguero, Prov. Limon, L-N-285000-588000, J. Solano, Apr. 1989, COSTA RICA: INBIO: CRI1103069. 1 ♀, Juan Vinas; PANAMA: 1 ♀, La Chorrera. 1 ♀, Corazal (Canal Zone).

Distribution. Southern Mexico south to Panama.

Remarks. Hind wing area between CuA₂ and CuP with or without spatulate scales, consequently this species can be found in two different parts of key.

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Figs. 36–43. 36. *Aureopteryx argentistriata* (Hampson), Wing length = 7 mm. 37. *Aureopteryx olufsoni* Solis & Adamski, Wing length = 6 mm. 38. *Chilozele trapeziana* (Sepp), Wing length = 12 mm. 39. *Cosmopterosis thetysalis* (Walker), Wing length = 7 mm. 40. *Dicymolomia metalophota* (Hampson), Wing length = 4 mm. 41. *Eupoca bifascialis* (Walker), Wing length = 9 mm. 42. *Eupoca chicalis* (Schaus), Wing length = 5 mm. 43. *Eupoca haakei* Solis & Adamski, Wing length = 8 mm.



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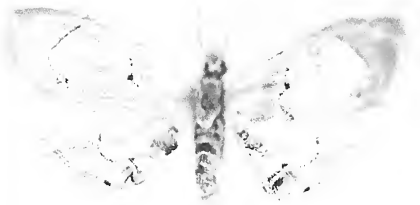
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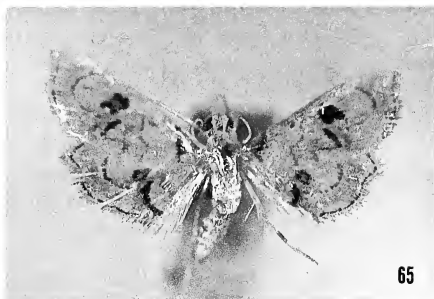
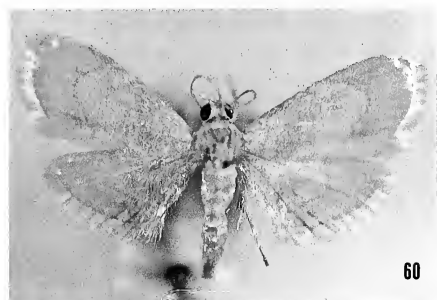


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Figs. 60–67. 60. *Lipocosma calla* (Kaye), Wing length = 5 mm. 61. *Lipocosma fonsecai* Solis & Adamski, Wing length = 4 mm. 62. *Lipocosma furvalis* (Hampson), Wing length = 5 mm. 63. *Lipocosma nigripictalis* Hampson, Wing length = 7 mm. 64. *Lipocosma pitilla* Solis & Adamski, Wing length = 5 mm. 65. *Lipocosma rosalia* Solis & Adamski, Wing length = 5 mm. 66. *Parambia gnomosynalis* Dyar, Wing length = 5 mm. 67. *Stegea hermalis* (Schaus), Wing length = 5 mm.

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LITERATURE CITED

- Amsel, H. G. 1956. Microlepidoptera Venezolana. Bol. Entomol. Ven. 10:(1-2), 1-336 (1956, (3-4), pl. I-CX (1957).
- Becker, V. O. 1986. Correct name for the species of *Chilozele* (Lepidoptera: Pyralidae) whose caterpillars damage cassava in South America. Bull. Entomol. Res. 76:195-198.
- Clarke, J. F. G. 1941. The preparation of the slides of the genitalia of Lepidoptera. Bull. Brooklyn Entomol. Soc. 36:149-161.
- Druce, H. 1899. Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera. Supplement, Vol. 2. 622 pp.
- Dyar, H. G. 1914. Report on the Lepidoptera of the Smithsonian Biological Survey of the Panama Canal Zone. Proc. U.S. Natl. Mus. 47(2050):139-350.
- Forbes, W. T. M. 1923. The Lepidoptera of New York and neighboring states. Part I. Cornell Univ. Agric. Exper. Stat. Mem. 68:1-729.
- Hampson, G. F. 1897. On the Classification of two Subfamilies of Moths of the Family Pyralidae: Hydrocampinae and Scopariinae. Trans. Entomol. Soc. London Part 2, 7:127-692.
- Hampson, G. F. 1898. A Revision of the Moths of the Subfamily Pyraustinae and Family Pyralidae. Proc. Zool. Soc. London 7:590-761.
- Hampson, G. F. 1906. Descriptions of New Pyralidae of the Subfamilies Hydrocampinae and Scopariinae. Ann. Mag. Nat. Hist. (7)18:455-472.
- Hampson, G. F. 1912. Descriptions of New Species of Pyralidae of the Subfamily Pyraustinae. Ann. Mag. Nat. Hist. (8)9:149-174.
- Hampson, G. F. 1913. Descriptions of New Species of Pyralidae of the Subfamily Pyraustinae. Ann. Mag. Nat. Hist. (8)11:509-524.
- Hampson, G. F. 1917. Descriptions of New Pyralidae of the Subfamilies Hydrocampinae, Scopariinae, & etc. Ann. Mag. Nat. Hist. (8)19:458-473.
- Kaye, W. J. 1901. A preliminary catalogue of the Lepidoptera Heterocera of Trinidad. Trans. Entomol. Soc. London Part 6:115-160.
- Klima, A. 1939. Pyralidae: subfam. Pyraustinae I. In: F. Bryk (ed.), Lepidopterorum Catalogus, Pars 89. Dr. W. Junk, s'-Gravenhage, 224 pp.
- Kornerup, A., and J. H. Wanscher. 1983. Methuen Handbook of Colour. Third Edition. Methuen and Co., Ltd., London, 252 pp.
- Maes, K. V. N. 1998. On the morphology of the gnathos in the Pyraloidea (Lepidoptera). Entomol. Scand. 28(4):381-390.
- Meyrick, E. 1936. On Venezuelan Pyralidina and Microlepidoptera. Veröffent. Deutsch. Kol.-Uebersee.-Mus. Bremen 1:321-334.
- Munroe, E. 1964. New genera and species of Glaphyriinae (Lepidoptera: Pyralidae). Canad. Entomol. 96:1261-1307.
- Munroe, E. 1972. Glaphyriinae. In: R. B. Dominick et al. (eds.), The Moths of America North of Mexico, Fasc. 13.1b. Pyraloidea (in part). The Curwen Press, London, 304 pp.
- Munroe, E. 1995. Glaphyriinae. Pages 43-45 in: J. B. Heppner (ed.), Checklist: Atlas of Neotropical Lepidoptera, Part 2. Association for Neotropical Lepidoptera, Gainesville, Florida, 243 pp.
- Munroe, E. and M. A. Solis. In press. Pyraloidea. In: N. Kristensen (ed.), Handbook of Zoology, Lepidoptera, Vol. 4. Walter de Gruyter & Co. Berlin.
- Nelson, J. M. 1968. Parasites and symbionts of nests of *Polistes* Wasps. Ann. Entomol. Soc. Am. 61:1528-1539.

- Rau, P. 1941. Observations on certain lepidopterous and hymenopterous parasites of *Polistes* wasps. *Ann. Entomol. Soc. Am.* 34:355–366.
- Schaus, W. 1912a. New species of Heterocera from Costa Rica. *Ann. Mag. Nat. Hist.* (8)9: 289–311.
- Schaus, W. 1912b. New species of Heterocera from Costa Rica. *Ann. Mag. Nat. Hist.* (8)9: 656–681.
- Schaus, W. 1920. New species of Neotropical Pyraustinae (Lepid.) *Proc. Entomol. Soc. Washington* 22(7):172–190.
- Sepp, J. (1828–[1855]). *Surinaamsche vlinders*. Verfaber Amsterdam, 328 pp.
- Walker, F. 1859–1866. List of the Specimens of Lepidopterous Insects in the Collection of the British Museum, Parts 16 to 35. London, Edward Newman.

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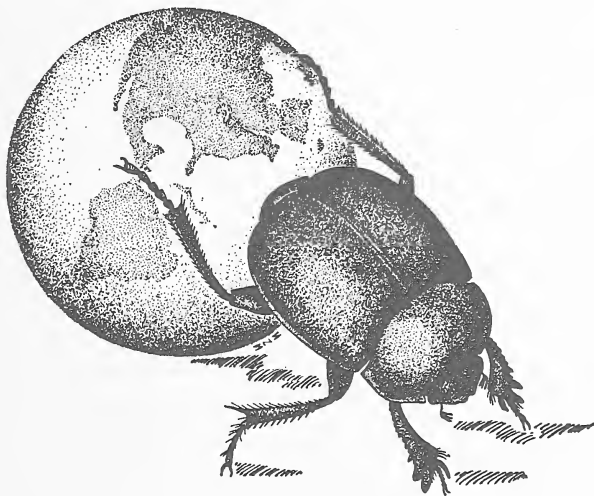
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**A NEW SPECIES OF *PARALYCAMBES* KORMILEV FROM
SOUTH AMERICA (HEMIPTERA: HETEROPTERA: COREIDAE:
MEROPACHYDINAE)**

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Abstract.—The South American genus *Paralycambes* Kormilev (Coreidae: Meropachydinae: Spathophorini) is redescribed, and one new species *P. pronotalis* from Venezuela and Brazil is described. New records for *P. misionensis* are given. Dorsal habitus illustrations and drawings of antennae, head, pronotum, scutellum, mesothorax, metathorax, metathoracic peritreme and male and female genitalia are provided.

The coreid genus *Paralycambes* Kormilev, 1954, belongs to the tribe Spathophorini (Coreidae: Meropachydinae) and was described from Paraguay and Argentina. It is known only from the type species *P. misionensis* Kormilev, 1954. Since it was described no new species have been assigned to it, and no subsequent papers mentioned or added new information on the genus or its species.

The tribe Spathophorini are characterized by the triangular and flat scutellum, shorter than the clavus, hind femora not attaining the apex of abdomen, antennal segment IV usually slender, and abdominal spiracles elliptical and positioned between the anterior and middle third of each segment (Kormilev, 1954).

In this contribution I redescribe the genus *Paralycambes* and include and illustrate for the first time the male and female genitalia, describe a new species from Venezuela and Brazil, and add new distributional records for *P. misionensis*.

The following abbreviations are used in the text: Museum Nacional, Río de Janeiro, Brazil (MNR); Universidad Central de Venezuela, Maracay (UCV); University of Minnesota, Insect Collection (UMSP); Instituto de Biología, Universidad Nacional Autónoma de México (UNAM); Museum der Humboldt Universitat zu Berlin, Germany (ZMB).

All measurements are in millimeters.

Paralycambes Kormilev

Paralycambes Kormilev, 1954. Rev. Ecuat. Ent. 2: 180-181

Redescription. *Head.* Wider than long, pentagonal, not declivent, dorsally flat; tylus unarmed, apically and dorsally globose, raised, extending anterior to and higher laterally than juga and antenniferous tubercles; juga unarmed, shorter than tylus; space between antenniferous tubercles filled by tylus, the space between them smaller than width of one tubercle; antenniferous tubercles unarmed, not protuberant; antennae shorter than body; antennal segment I robust, cylindrical, thickest, slightly curved outward, longer than head, with sulcus hard to see; segments II and III cylindrical, barely flattened, sulcate; segment IV fusiform; antennal segment IV the

longest, III the shortest, II shorter than I; length of antennal segment IV 2.1 to 3.0 times longer than total length of head; ocelli close to eyes; distance between ocelli 2.8 to 3.0 times the diameter of an ocellus; distance between ocelli and eye 0.7 to 1.0 times the diameter of an ocellus; preocellar pit obliquely deep; eyes globose, slightly protuberant, upper margin located at the same level or above the vertex and frontal area; mandibular plate absent; bucculae squarish, raised, short, entire, not projecting beyond antenniferous tubercle, meeting posteriorly and closed; rostrum reaching middle third of mesosternum; rostral segment III shortest, I, II, and IV subequal in length; ventral surface below and behind the bucculae without tubercle.

Thorax. Pronotum wider than long, trapeziform, slightly declivent, with posterior border subequal to base of scutellum in width; collar wide; antero-lateral angles obtuse; humeral angles produced laterally into a broad or triangular expansion, apically armed with an acute medium-sized spine, and with broad marginal spines or tubercles; calli entire, not elevated, separated at midline by a short longitudinal furrow; anterior margin smooth and curved; antero-lateral margin obliquely straight to sinuate, uniformly subcrenate; postero-lateral border straight, abruptly crenate; triangular process broad, and almost bifid; posterior border barely straight, the margin with an irregular ridge (Figs. 2-4). Prosteronum broad, convex, with posterior third in front of the area between fore legs produced into a narrow acute projection; mesosternum flat, anterior third in front of the area between the fore legs, raised into a broad and subacute keel, posterior third between middle legs raised into a squarish plate, laterally emarginated, with posterior border straight; metasternum broad, hemispherical, with anterior border laterally folded and raised on two medium-sized and slender arms close to mesocoxae; posterior mesosternal plate laying between the metasternal anterior arms; posterior border of metasternum straight, with lateral angles projecting into broad plate, laying against the metacoxae (Fig. 5); posterior border of metathorax almost straight and entire; lateral margin of mesopleura slightly raised; metathorax laterally not expanded, in dorsal view with metapleura and hind acetabulae not visible; metathoracic peritreme elongate, fusiform, not bilobed, located near lower margin of metapleuron, with the upper third closed; canal elongate, with raised sides; anterior lobe rounded; evaporative area poorly developed (Fig. 6).

Legs. Hind coxae not strongly separated, distance between them 1.0 to 1.4 times the diameter of one coxae, and apically without tubercle; fore and middle femora moderately robust, ventrally with two apical acute spines, and one row of short subapical tubercles; hind femora markedly incrassate, attaining posterior third of abdominal sternite V or anterior third of VI; dorsal surface smooth, ventrally armed with two apical spines and one row of strong spines and tubercles; fore and middle tibiae unarmed, sulcate, slightly widened distally; hind tibiae almost straight, shorter than length of hind femora, with outer margin sulcate, not expanded, and inner margin not expanded, and unarmed except for one long and broad spine at distal third.

Scutellum. Longer than wide, triangular, flat, and shorter than clavus; basal disc transversely raised; apex subacute; lateral margins emarginate.

Hemelytra. Macropterous, reaching apex of abdomen; clavus and claval suture not covered by the scutellum; costal margin emarginate; apical margin obliquely straight, with apical angle narrowed, very long, extending beyond middle third of hemelytral membrane.

Abdomen. Gradually narrowed beyond middle, and posteriorly expanded (more conspicuous in male than female); connexival segments scarcely elevated; male posterior angle IV to VI

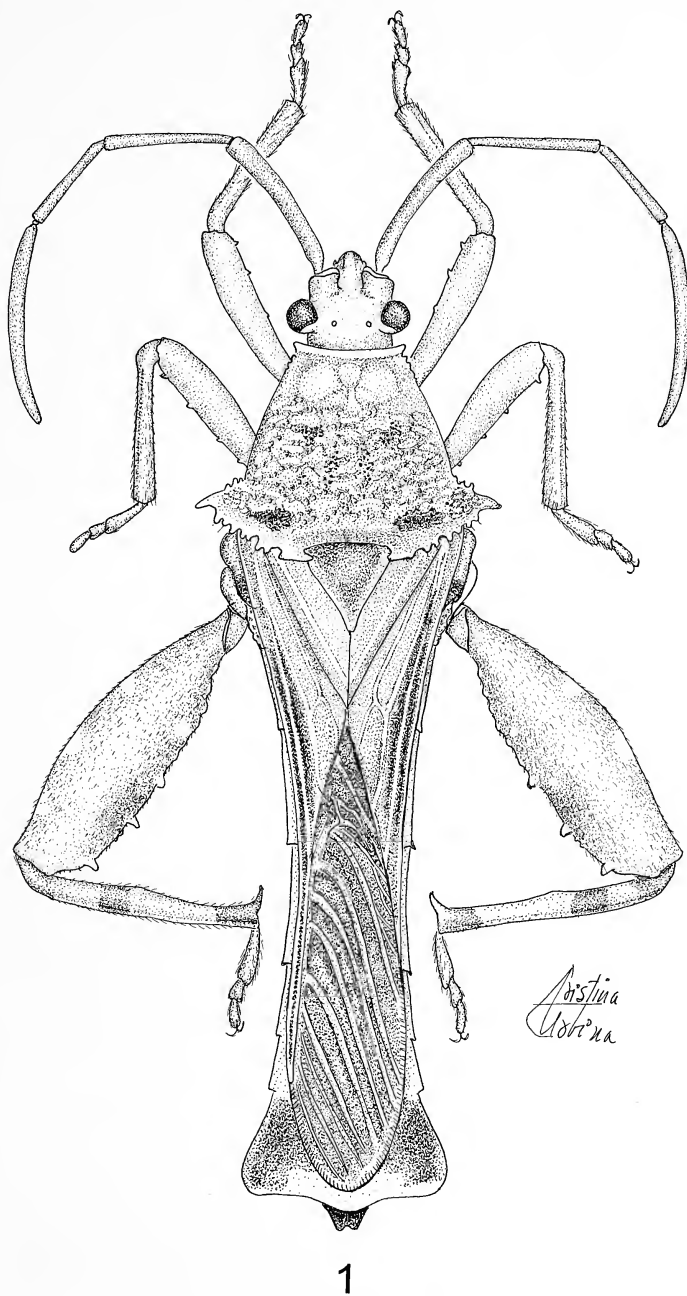
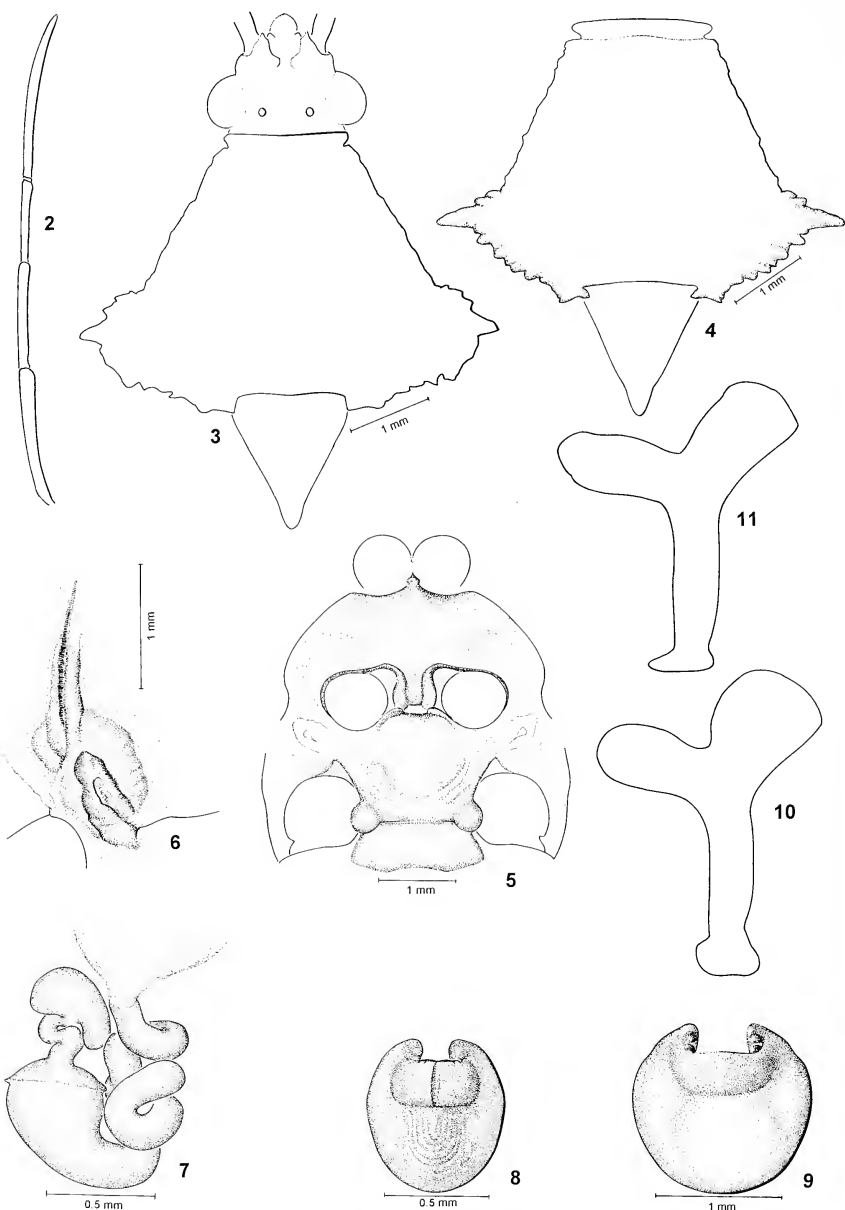


Fig. 1. Dorsal view of *Paralycambes pronotalis*.



Figs. 2, 4-6, 9-10. *Paralcambes pronotalis*. Fig. 2. Antenna. Fig. 4. Pronotum and scutellum in dorsal view. Fig. 5. Mesothorax and metathorax in ventral view. Fig. 6. Metathoracic peritreme. Fig. 9. Male genital capsule in caudal view. Fig. 10. Paramere. Figs. 3, 7-8, 11. *Paralcambes misionensis*. Fig. 3. Head, pronotum, and scutellum in dorsal view. Fig. 7. Spermatheca. Fig. 8. Male genital capsule in caudal view. Fig. 11. Paramere.

projected into short spine, segments II, III, and VII unarmed; female posterior angle of segments II to VII unarmed; abdominal sterna without medial furrow; abdominal spiracles elliptical; abdominal spiracle III closer to anterior border, and spiracles IV to VII situated nearer middle third; abdominal sternite II visible, slender, rectangular, without tubercle, and with lateral angles almost truncated; abdominal sternite III not expanded laterally. *Male genitalia*. Genital capsule simple, semiglobose; postero-ventral edge with a medial projection, protruding as a large hemispherical plate, medially with or without longitudinal sulcus (Figs. 8–9). Parameres. Shaft slender, almost parallel-sided, apically bilobate, with proximal lobe elongate and slender, and distal lobe broad, squarish or hemispherical (Figs. 10–11). *Female genitalia*. Abdominal sternite VII with plica and fissura; plica rectangular; fissura with inner margin overlapping; gonocoxae I subtriangular to hemispherical, closed in caudal view, exposed, and convex, in lateral view almost straight, with upper border rounded; paratergite VIII triangular, spiracle visible; paratergite IX rectangular, longer than paratergite VIII, in caudal view closed and slightly raised. *Spermatheca*. Bulb hemispherical, basal duct barely coiled, chamber dilated with small lateral spines, distal duct coiled, and relatively short membrane expansion (Fig. 7). *Integument*. Body surface shining, with clavus and corium rather dull; antennal segments and legs clothed with long to short decumbent to suberect setae; head, prosternum, mesosternum, metasternum, abdominal sterna, and connexival segments impunctate; pronotum, propleura, mesopleura, metapleura, clavus and corium punctate; scutellum transversely striate, basally with few punctures, apically almost creamy yellow; calli smooth.

Diagnosis. *Paralycambes* Kormilev is more closely related to *Lycambes* Stål than any other known Spathophorini. It can be recognized by eight characters: 1, Antennal segments II and III cylindrical, never apically dilated. 2, Metasternum flat, without conical tubercles. 3, Body length shorter than 26.00 mm. 4, Posterior border of pronotum with triangular process. 5, Hind femora gradually incrassate toward the apex. 6, Fore and middle femora dorsally smooth. 7, Hind tibiae shorter than length of hind femora. 8, Humeral pronotal angles angulate, never obtusely rounded. *Paralycambes* can be distinguished by the mesosternum flat, the humeral angles produced laterally into medium-sized and acute spine, and the postero-lateral borders of pronotum abruptly crenate. In *Lycambes* the mesosternum is clearly elevated, the humeral angles are sharp but hardly produced laterally, and the postero-lateral borders are almost smooth or only with upper half finely nodulose.

Type species. *Paralycambes misionensis* Kormilev.

Paralycambes misionensis Kormilev

Paralycambes misionensis Kormilev, 1954. Rev. Ecuat. Ent. 2: 181–183

Figs. 3, 7–8, 11

Geographical distribution. Previously known from Paraguay and Argentina. Paraguay (S. Estanislao) and Argentina (Misiones, Rio Uruguay).

Material examined. BRAZIL: 1 ♂, Bahia, G, Bondar (UNAM). PARAGUAY: 2 ♂, Departamento San Pedro Carumbe, 8.iii.1966, 10.II.1973, R. Golbach (UNAM). One female, x.1925, S. V. Fiebrig. (ZMB).

Paralycambes pronotalis, new species

Figs. 1-2, 4-6, 9-10

Description. *Male.* Dorsal coloration bright chestnut orange, with following areas bright reddish brown to black: the scattered punctures on pronotal disk, humeral angles, and basal lateral angles of scutellum; antennal segments I to III bright chestnut orange with apical join reddish brown, and segment IV black with dark orange reflections; apex of scutellum pale orange yellow; clavus dirty yellow with vein and claval suture orange; corium rather dull orange yellow, with veins paler, and the space between veins of exocorium black; hemelytral membrane dark ambarine, with basal angle and veins darker, with metallic blue-green reflections; connexival segments II to V bright orange yellow, VI bright orange yellow with middle third reddish brown, and VII black with anterior angle bright orange yellow; dorsal abdominal segments black with scent glands IV-V and V-VI yellow. *Ventral coloration.* Prosternum, mesosternum, metasternum, metathoracic peritreme, and abdominal sterna dull orange yellow; head, rostral segments I to IV, propleura, mesopleura, metapleura, acetabulae, pleural margins of abdominal sterna II to VII, and genital capsule bright orange yellow with following areas black: apex of rostral segment IV, base of metathoracic peritreme, one irregular spot on propleura, three on mesopleura, and one on metapleura; mesosternum laterally pale dark grey; mesopleura and metapleura with a pale yellow area, scattered with small bright red marks; coxae, trochanters, and fore and middle femora bright orange yellow; hind femora bright orange yellow, with pale yellow discoidal spots, and apically with bright reddish brown marks; fore and middle tibiae bright orange yellow; hind tibiae bright orange yellow with two bright reddish-brown rings, one near basal third, the other on apical third; tarsi bright dark orange yellow with apex of fore tarsi darker. *Thorax.* Pronotum with humeral angles produced laterally into a triangular slender expansion, apically armed with an acute medium-sized spine, with broad marginal spines and tubercles (Fig. 4) *Genital capsule.* Posteroventral edge with a medial projection, protruding as a large hemispherical plate, without longitudinal sulcus (Fig. 9). *Paramere.* Shaft slender, apically bilobate, with proximal lobe elongate and slender, and distal lobe broad and hemispherical (Fig. 10).

Measurements. Length of head: 1.68; width across eyes: 2.16; interocular space: 1.08; interocellar space: 0.45; preocular distance: 1.16; length of antennal segments: I, 3.16; II, 2.32; III, 1.84; IV, 3.60. Pronotal length: 3.16; width across frontal angles: 2.12; width across humeral angles: 5.56. Hind leg. Length femur: 5.95; length tibiae: 4.52. Scutellar length: 1.80; width: 1.52. Total body length: 17.45.

Female. Color similar to male. Antennal segment IV pale reddish orange; connexival segment VIII bright reddish brown with posterior third dark bright orange, and segment IX bright reddish brown; abdominal segment VIII and IX, and genital segments bright orange. *Measurements.* Length of head: 1.68; width across eyes: 2.24; interocular space: 1.12; interocellar space: 0.44; preocular distance: 1.06; length of antennal segments: I, 3.32; II, 2.60; III, 2.04; IV, 4.00. Pronotal length: 3.68; width across frontal angles: 2.20; width across humeral angles: 5.80. Hind leg. Length femur: 6.22; length tibia: 4.89. Scutellar length: 1.76; width: 1.60. Total body length: 18.60. *Variation.* 1, Head with a pale yellow median vitta running through the interocellar space. 2, Antennal segments I to III bright pale orange yellow, and IV

dark orange yellow. 3, Genital capsule pale yellow with punctures black to reddish brown.

Types. Holotype, ♂, VENEZUELA, Litoral D.F., Chichiriviche, 20.XI.1976, C. Bordon. (UNAM). Paratypes: VENEZUELA: 1 ♂, Perija, Cajmera (Zulia), 14.iv.1960, Joly (UCV); 1 ♂, Monagas, 82 km., SE, of Maturin, 2.ix.1975, (UMSP). BRAZIL: 1 ♂, Para, Santarem, 6.iii.1956, Elias and Roppa (MNR); 1 ♀, Amapa, Mozogao, between Jari and Villa Nova, ii.1961, J. C. M. Carvalho (UNAM).

Discussion. *Paralycambes pronotalis*, new species, is recognized by the shape of the paramere, with the distal lobe hemispherical and broadened (Fig. 10); the posteroventral border of the genital capsule entire, without a medial longitudinal sulcus (Fig. 9); and the humeral angles of the pronotum produced laterally into triangular and slender expansions (Fig. 4). In *Paralycambes misionensis* Kormilev, the only previously known species, the distal lobes of parameres are squarish (Fig. 11), the posteroventral border of genital capsule has a median longitudinal sulcus (Fig. 8), and the humeral angles are produced laterally into broad expansions (Fig. 3).

Etymology. The specific epithet of the species refers to the shape of the pronotum.

Geographical distribution. Known only from Venezuela and Brazil.

ACKNOWLEDGMENTS

I express my appreciation to the following colleagues and institutions for the loan of specimens and other assistance relevant to this study: the late Jose C. M. Carvalho (MNR); Eduardo Osuna (UCV); Ernesto Barrera (UNAM); Philip J. Clausen (UMSP); Juergen Deckert (ZMB). Cristina Urbina prepared the dorsal view illustration.

LITERATURE CITED

Kormilev, N. 1954. Notas sobre Coreidae Neotropicales II; (Hemiptera) Merocorinae de la Argentina y paises limitrofes. Rev. Ecuat. Ent. 2:153–187.

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A NEW SPECIES OF *EPIPOLOPS* H.S. FROM SOUTH AMERICA (HETEROPTERA: LYGAEOIDEA: GEOCORIDAE)

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Abstract.—*Epipolops rettenmeyeri* is described as a new species from Ecuador and Peru. A key to the known species of *Epipolops* H.S. is included. *E. meridionalis* Piran is reduced to a junior synonym of *E. frondosus* H.S. New country records are given for three species. The systematic position of the genus is summarized.

Key words: Epipolops, Lygaeoidea, Geocoridae, Neotropical.

The species of *Epipolops* H.S., with their eyes placed at the end of elongate divergent stalks and usually with large projections extending laterally from the sides of the pronotum, are certainly among the most bizarre of lygaeoid insects.

The systematic relationships of the genus have until recently been obscure. Stål (1868) placed the genus in the Geocorida, Ashlock (1957) in the Cyminae. Hamid (1975) stated they were not members of the Cyminae, but did not place them. Brailovsky (1990) placed them in the Bledionotinae and Slater & O'Donnell (1995) in the tribe Pamphantini within the Bledionotinae both without comment. Elsewhere (Slater, in press) I discuss their systematic position in detail, treating them as a separate tribe in the subfamily Pamphantinae of the Geocoridae (*sensu* Henry, 1997). The evidence for this will not be repeated here other than to say that the combination of the position of the abdominal spiracles and in particular the distinctive areolate punctures (synapomorphy) indicate a close relationship to the New World pamphantine lygaeoids.

Brailovsky (1990) gives a key to the known species with illustrations of the various shapes of the pronotum. The English key provided here is modified from that of Brailovsky.

All measurements are in millimeters.

Unfortunately nothing seems to be known of the biology of these peculiar insects. Collecting records suggest that they live on the foliage of plants. *E. oculuscancri* (DeGeer) was taken in Costa Rica on "*Psidium quajava*" and intercepted at Laredo, Texas on orchids from Mexico.

***Epipolops rettenmeyeri*, new species**

General coloration nearly uniformly pale yellow. Scutellum with a white, elevated, calloused, median stripe diverging anteriorly into a pair of widely separated "Y" shaped arms. Posterior margin of eye stalk with a narrow, elongate, brown stripe. Antennae pale testaceous. Apical two-thirds of fourth antennal segment dark red, strongly contrasting with pale proximal portion. Eyes bright red. Abdominal sternum with an irregular dark sublateral stripe, somewhat broken into spots anteriorly and

nearly reaching meson on genital capsule. Entire dorsal surface bearing elongate upright hairs. Head impunctate. Large areolate punctures present on pronotum, scutellum and on clavus. Those on clavus forming two complete and a partial third row.

Head with eyes at ends of elongate, divergent stalks. Length eye stalk 0.84. Width across base of head 0.60. Length head 0.64, width across eyes 1.66. Pronotum with two pairs of lateral projections, anterior pair spatulate with 7 or 8 elongate setigerous hairs arising from projection; posterior projection arising near posterior margin of pronotum at humeral angles, somewhat hatchet or scimitar shaped, curving anteriorly, outer margin toothed or crenulated. Length pronotum 1.04. width across humeri (excluding projections) 1.58. Length scutellum 0.64. width 0.82. Length claval commissure 0.60. Corium with broad lateral explanate flanges, margin of flange abruptly expanded at base but without a distinct tooth. Membrane considerably exceeding apex of abdomen. Midline distance apex clavus-apex corium 1.28. Midline distance apex corium-apex membrane 0.60. Maximum width across hemelytra 2.00. Metathoracic scent gland auricle narrowly elliptical; evaporative area covering essentially all of both meta- and mesopleuron. Fore femur only moderately incrassate, mutic. Labium extending between mesocoxae, first segment barely attaining base of head. Length labial segments I 0.56, II 0.46, III 0.46, IV 0.34. Antennae slender, first segment somewhat enlarged, elongate, extending beyond eye stalks for approximately half its length. Length antennal segments I 0.62, II 0.56, III 0.40, IV 0.54. Total body length 5.32.

Types. Holotype, ♂, ECUADOR, Prov. Napo, 00°24'S, 76°36'W 'Limoncocha' 280 m. 18.vi.1975, No. 777, Ruth Chadab (USNM). Paratype: PERU: 1 ♂, Satipo, 9.VIII.1941, T. Paprzycki, "(J. E. Lutz collection)" (In J. A. Slater collection).

Discussion. This species is most closely related to *E. lenkoi* Canter and *E. arboricola* Brailovsky in having strongly spatulate projections from the anterior pronotal lobe. It differs from *E. lenkoi* in having a rather hatchet or scimitar shaped projection from the humeral pronotal angles. In *E. lenkoi* this posterior projection is also rather spatulate and is far removed from the posterior angle of the pronotum. (See Canter, 1964 and Brailovsky, 1990). In addition *E. rettenmeyeri* has a very different configuration to the explanate flange of the corium. In *E. lenkoi* the flange at the level of the apex of the scutellum is strongly sinuate, whereas it is nearly straight in *E. rettenmeyeri*. The first antennal segment of *E. rettenmeyeri* is similar to that of *E. arboricola* and thus much longer than is that of *E. lenkoi*. Although possibly variable when a series becomes available the color marking also seems to be distinctive for both *E. lenkoi* and *E. arboricola* have a pair of prominent dark spots in the area of the calli and on the humeral angles that are absent in *E. rettenmeyeri*.

Etymology. Named for my colleague Dr. Carl Rettenmeyer in recognition of his important entomological work in tropical Ecuador and for introducing the collector of the holotype Dr. Ruth (Chadab) Crepet to the fauna of the type locality.

NEW COUNTRY RECORDS

Epipolops oculuscancricri (DeGeer) Guyana ("British Guiana").

Epipolops acuminatus (Distant) Mexico (Sinaloa), Honduras.

Epipolops frondosus H.S. Paraguay.

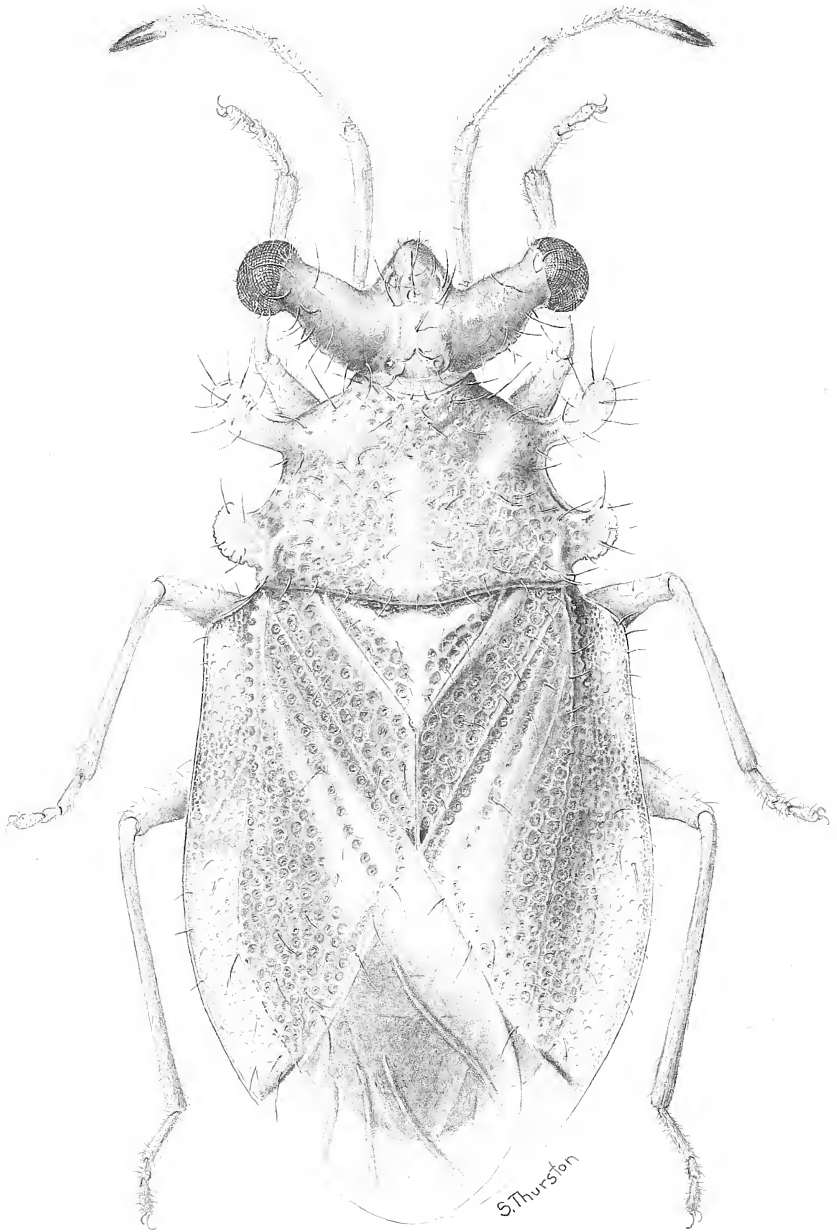


Fig. 1. *Epipolops rettenmeyeri* new species. Dorsal view.

KEY TO SPECIES OF EPIPOLOPS

1. Lateral pronotal margins lacking conspicuous projecting spines, spatulate lobes or setiferous lamellae *oculuscancri* (DeGeer)
- 1a. Lateral pronotal margins with at least one pair of projecting spines, lobes or lamellae 2
2. Anterior pronotal lobe lacking a conspicuous lateral projection . . . *acuminatus* (Distant)
- 2a. Both anterior and posterior pronotal lobes with conspicuous lateral projections 3
3. Lateral projections of both anterior and posterior pronotal lobes consisting of a single sharp, acute tipped, sometimes recurved spine 4
- 3a. Lateral pronotal projections of both anterior and posterior lobes with spatulate, crenulate or multi-pointed, setiferous plates; sometimes anterior projection backward curved and not spatulate 5
4. Antero-lateral margin of corium with a large, conspicuous, laterally projecting tooth *quadriscopinus* Stal
- 4a. Antero-lateral margin of corium somewhat expanded but lacking a large conspicuous tooth *mucronatus* (Distant)
5. Anterior pronotal projections forming a series of serrate teeth, with an elongate seta projecting from each tooth. *frondosus* Herrich-Schaeffer
- 5a. Anterior pronotal projection either a single spatulate lobe or curved tooth 6
6. Lateral margin of corium with a conspicuous laterally directed spine near base *bellus* Brailovsky
- 6a. Lateral corial margin basally either evenly rounded or bluntly angulate but never with a conspicuous laterally directed spine 7
7. First antennal segment short, not extending anteriorly beyond pedunculate eyes; lateral projections from posterior pronotal lobe spatulate, set far forward of humeral pronotal angles *lenkoi* Canter
- 7a. First antennal segment relatively elongate, extending for one-half its length beyond eyes; lateral projections of posterior pronotal lobe not spatulate 8
8. Anterior pronotal projections broadly spatulate; posterior projection rather hatchet-shaped, curving anteriorly; dorsal surface lacking black spots *rettenmeyeri* n.sp.
- 8a. Anterior pronotal projections not rounded and spatulate, but bluntly truncate at distal end; posterior pronotal projection bluntly rounded, not curving anteriorly; black spots present on pronotal calli and humeral pronotal angles *arboricolus* Brailovsky

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LITERATURE CITED

- Ashlock, P. D. 1957. An investigation of the taxonomic value of the phallus in the Lygaeidae (Hemiptera-Heteroptera). *Annals of the Entomological Society of America* 50:407-426.
- Brailovsky, H. 1990. Descripcion de dos especies nuevos del genero *Epipolops* H.S. de Sudamerica (Hemiptera-Heteroptera-Lygaeidae-Bledionotinae). *Anal. Inst. Biol. Univ. Nac. Auton. Mexico Ser. Zool.* 61:125-132.
- Canter, H. M. 1964. Contribuicao ao conhecimento do genero *Epipolops* H.-Schaeffer, 1853 (Hemiptera, Lygaeidae, Geocorinae). *Papeis Avulsos do Dept de Zoologia, Secretaria da Agriculture, Sao Paulo, Brasil* 16:63-70.

- Hamid, A. 1975. A systematic revision of the Cyminae (Heteroptera: Lygaeidae) of the world with a discussion of the morphology, biology, phylogeny and zoogeography. *Occasional Papers of the Entomological Society of Nigeria* 14:1-179.
- Henry, T. J. 1997. Phylogenetic analysis of family groups within the infraorder Pentatomomorpha (Hemiptera: Heteroptera) with emphasis on the Lygaeoidea. *Annals of the Entomological Society of America* 90:276-301.
- Slater, J. A. (in press) The systematic position of the Pamphantinae with the description of two new tribes and a new species of *Cattarus* Stal (Hemiptera: Lygaeoidea: Geocoridae). *Acta Soc. Bohem.*
- Slater, J. A. and J. O'Donnell. 1995. *A Catalogue of the Lygaeidae of the World (1960-1994)*. New York Entomological Society vii-xv + 410 pp.
- Stal, C. 1868. Hemiptera Fabriciana. *Kongliga Svenska Vetenskaps-Akademien Handlingar* 7(11):1-148.

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**GEOGRAPHIC DISTRIBUTIONS OF *PERISTENUS CONRADI* AND
P. DIGONEUTIS (HYMENOPTERA: BRACONIDAE), PARASITES
OF THE ALFALFA PLANT BUG AND THE TARNISHED PLANT
BUG (HEMIPTERA: MIRIDAE) IN THE NORTHEASTERN
UNITED STATES**

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Abstract.—*Peristenus digoneutis* Loan, an introduced parasite of the tarnished plant bug, *Lygus lineolaris* (Palisot) (a native species), has spread from its original establishment point in northwestern New Jersey into six additional states. It has been found in 36 counties, but likely is more widespread. Its dispersion has mostly been to the northeast, and has not occurred south of latitude 40°N. *Peristenus conradi* Marsh, an introduced parasite of the alfalfa plant bug, *Adelphocoris lineolatus* (Goeze) (an introduced insect), has spread from its initial establishment location in northern Delaware into two other states. It is known from a total of nine counties, but probably also is present in others. Both parasitic wasp species are now established widely enough that field studies can be conducted in several states.

Key words: *Adelphocoris*, alfalfa, *Lygus* spp., parasites, *Peristenus* spp.

Two species of European parasites of mirid plant bugs have recently become established in the northeastern United States. Both are braconid wasps—*Peristenus digoneutis* Loan, a parasite of *Lygus* nymphs (Day et al. 1990), and *P. conradi* Marsh, a parasite of *Adelphocoris* nymphs (Day et al. 1992).

Since these initial reports, these two wasps have continued to disperse, and our limited surveys have found them in a total of six new northeastern states and in 40 additional counties. These results are reported in this paper, and are the results of surveys by all of the authors. Such geographic range data are used to estimate the rate of dispersion (which cannot be done in the country of origin), and to determine if a species' climatic limits have been reached. And once an introduced insect is known to be present in a new area, field ecological studies can be started.

MATERIALS AND METHODS

Surveying for geographic range of parasites. Timing of field sampling is especially important, for maximum efficiency. Sampling at peak parasitism will provide the largest number of parasites, for the best chance of detecting a "new" species. Peak parasitism occurs at or near the population peak of the mirid nymphs (Day, unpubl.),

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which also provides the largest sample of hosts. Because *P. conradi* only parasitizes first generation *Adelphocoris* (Day et al., 1992), and *P. digoneutis* parasitizes first and second generation *Lygus* (Day et al., 1990), field surveys were scheduled for periods when these events were expected to occur. As the growing season advanced from south to north, our surveys gradually moved northward also. Weekly samples of mirid nymphs throughout each year, at two or three locations, assisted in predicting the dates when each species would reach maximum numbers.

A safety glass-topped sleeve cage (Day et al., 1990) was used to prevent escape of the swept mirids while they were being identified, counted, and collected, and to retain adult parasites. Swept *P. digoneutis* adults were identified with a hand lens in the field, greatly speeding up the survey (further sampling in the same county was therefore not necessary). Identification of *P. conradi* adults requires 20–30× magnification, which is usually done with a binocular microscope in the laboratory, but identification of swept adults still provides new location records much faster than conventional rearing (which requires 10 months because of the obligatory diapause of all *P. conradi*, and of most *P. digoneutis*).

Plant bug numbers varied from one alfalfa field to another, but were nearly always higher in older fields and in taller alfalfa (Day, unpubl.), so sweeping was concentrated in such fields when they were available. Counties to be sampled were selected because they were adjacent to counties where the parasite had previously been detected, or were along the northeastern direction of parasite dispersion.

Sampling. The minimum sample per field was 100 half-cycle sweeps with a 37-cm dia. beating net. Most *P. digoneutis* were reared from *L. lineolaris*, and most *P. conradi* were reared from *A. lineolatus*, but all seven mirid species which were commonly swept in alfalfa, alfalfa-grass, and red clover fields were retained (these species are named in Table 3). Surveys were made in the years listed in Table 1. In addition to samples from these special surveys, regular weekly or biweekly samples were taken throughout the growing season at several locations to determine the timing of parasite occurrence in the field, which differs slightly from year to year. This monitoring was done near Blairstown, NJ (*P. digoneutis*, 1981–1994), at Newark, DE (*P. conradi*, 1988–1994), and near Woodstown, NJ (*P. conradi* 1988–1994). Native parasites were sampled in the same way at all 3 locations.

Each sample of nymphs was reared to determine the species of parasite present (Day, 1994). The three alfalfa-feeding mirids (*Adelphocoris*, *Halticus*, & *Lygus*) were fed alfalfa “bouquets,” and the four grass-feeding mirids (*Leptopterna*, *Megaloceroea*, *Stenotus*, & *Trigonotylus*) were fed grass foliage and seed heads. Rearing procedures and cages were as outlined in Day (1996).

Healthy nymphs, as well as those injured during collecting that were not likely to survive the rearing process, were frozen at -20°C for later dissection (Day, 1994), to determine the degree of parasitism. These results will be reported elsewhere.

RESULTS AND DISCUSSION

Distribution of *Peristenus digoneutis*. Previously, this introduced parasite of *Lygus lineolaris* was known to be present in three counties, in two states (New Jersey and New York; Day et al., 1990). Since that time, we have found it in an additional five states (Pennsylvania, Massachusetts, New Hampshire, Vermont, and Connecticut),

Table 1. First county and state recoveries of *Peristenus digoneutis*.

State	County	Nearest town	Parasitized host collected	
			Date	By
NJ	Warren	Marksboro	7/06/84	Day
NJ	Sussex	Fredon	6/16/88	Day
NY	Orange	Warwick	7/07/89	Day
NJ	Morris ^a	Long Valley	7/28/92	Chianese & Crowley
(DE	New Castle	Newark	7/13/92	Day & Tropp) ^b
NY	Ulster	Wallkill	6/23/93	Day
PA	Northampton	Wind Gap	6/16/93	Day
MA	Franklin	Deerfield	6/29/93	Van Driesche & McCool
	Hampden	Agawam	8/04/93	Van Driesche & McCool
NJ	Hunterdon	Hampton	8/03/93	Chianese & Crowley
PA	Monroe	Kresgeville	7/26/94	Romig
NY	Albany	Preston Hollow	8/02/95	Day
	Columbia	Hudson	6/14/95	Tropp
	Delaware	Lake Delaware	8/01/95	Day
	Dutchess	Hibernia	6/08/95	Tropp
	Greene	Coxsackie	6/14/95	Tropp
	Renssalaer	Poestenkill	8/01/95	Tropp
	Schoharie	North Blenheim	8/02/95	Day
NH	Hillsborough	Milford	7/26/95	Eaton
PA	Carbon	Beltzville	7/25/95	Romig
VT	Bennington	S. Shaftsbury	8/02/95	Tropp
	Windham	Vernon	8/02/95	Tropp
CT	Hartford	Suffield	7/20/95	Tropp
	Litchfield	Bakersfield	7/19/95	Tropp
NY	Broome ^a	Itaska	7/09/96	Tropp
	Clinton	W. Chazy	7/10/96	Tropp
	Oneida	Paris Station	8/21/96	Tropp
	Otsego	Richfield Stat.	8/24/96	Tropp
	Saratoga	Waterford	7/23/96	Tropp
	Washington	Easton	7/23/96	Tropp
NH	Belknap	Belmont	8/23/96	Eaton
	Grafton	Orford	8/22/96	Eaton
	Merrimac	Concord	8/15/96	Eaton
	Rockingham	Epping	8/14/96	Eaton
	Strafford	Madbury	8/09/96	Eaton
PA	Luzerne ^a	Conyngham	8/06/96	Romig
	Wyoming	Factoryville	8/14/96	Romig

All records are based on reared female parasites, unless otherwise noted below.

^a Tentative, based on male only (swept or reared).

^b Reared from nymphs collected in 1992 and 1993, but not in 1994 and 1995, so not counted as established here.

and in 33 more counties (Table 1). Fig. 1 shows the minimum range (dates within counties) and probable range limits (dates within lines) of *P. digoneutis*. The probable range limits are slightly larger than the known recovery counties because the parasite was detected in 100% of the counties that we surveyed in 1995, and in 59%

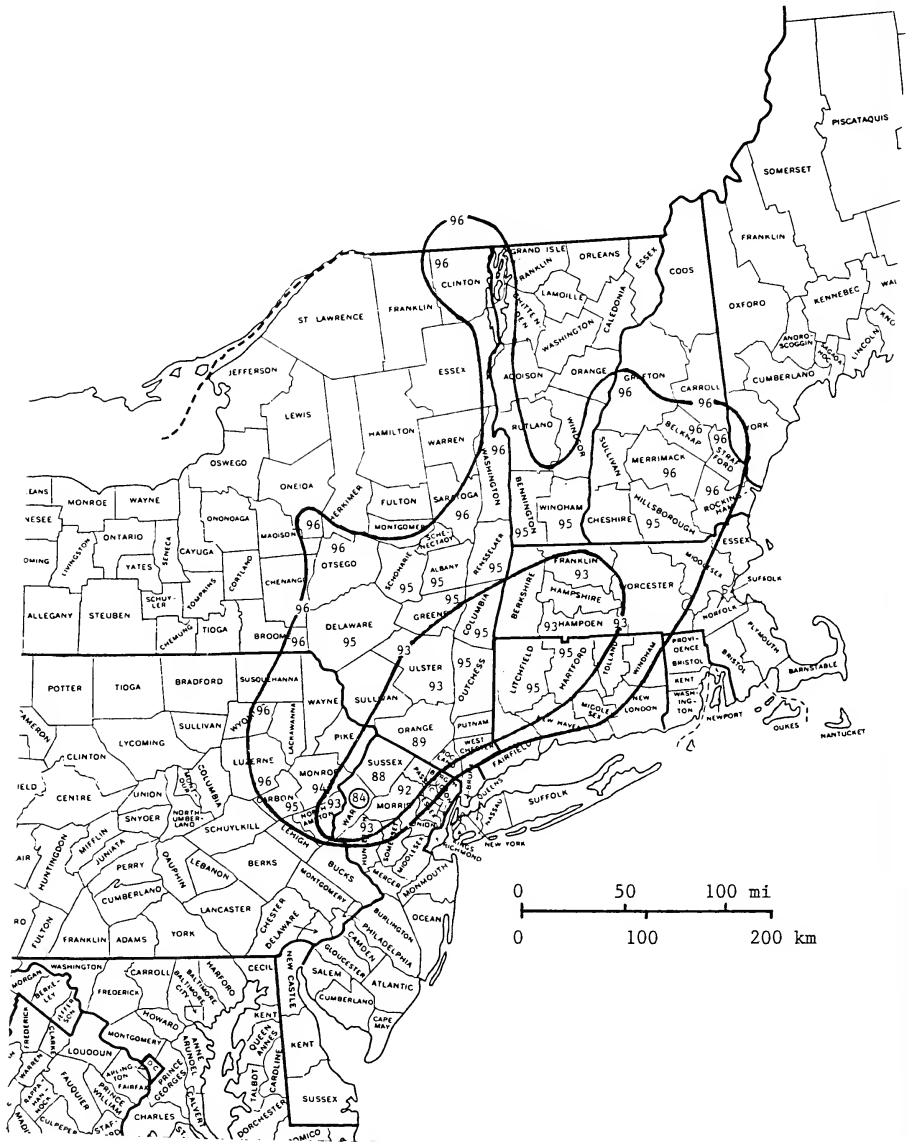


Fig. 1. Known and possible dispersion of *Peristenus digoneutis*, June 1997. The circled date shows the location and year where this parasite was first found to be permanently established in North America. Uncircled dates indicate when the parasite was first collected in each county. Years within the range line depict the probable dispersion by that year.

Table 2. First county and state recoveries of *Peristenus conradi*.

State	County	Nearest town	Parasitized host collected	
			Date	By
DE	New Castle	Newark	5/30/88	Day & Saunders
NJ	Burlington	Juliustown	5/31/90	Day & Saunders
NJ	Gloucester	Harrisonville	5/12/92	Tropp
	Monmouth	Marlboro	6/17/92	Day
	Salem	Cohansey	6/04/93	Tropp
NY	Middlesex ^a	Cranbury	6/10/93	Day
	Ulster	Wallkill	6/23/93	Day
NJ	Dutchess	Hyde Park	6/24/93	Day
	Cumberland	Carmel	6/02/94	Tropp

^a Based on a swept adult parasite only. The others are based on reared adult parasites.

of those sampled in 1996 (most of the counties lacking *P. digoneutis* in 1996 were represented by few field samples and/or small sample sizes): more negative counties would be expected if we had sampled past the "leading edge" of the *P. digoneutis* dispersion pattern.

The probable distribution of *P. digoneutis* (Fig. 1) now encompasses approximately 115,000 km² (45,000 mi²). Most of its natural dispersion has been to the northeast. Probably this is a result of two factors: the prevailing summer wind direction from the southwest, and the apparent inability of this species to survive in the warmer climate to the south (the parasite has only moved about 48 km [30 mi] south, in 12 years). This limit is approximately at 40.5° latitude, considerably south of the latitude (45°) where *P. digoneutis* was originally collected in Europe (its southern distributional limits there are unknown). Although genetic selection may eventually allow this parasite to move farther south, in the near future effective biological control of *Lygus* by *P. digoneutis* (Day, 1996) will probably be limited to the northern United States and southern Canada.

Distribution of *Peristenus conradi*. Initially, we detected this introduced parasite in just one county, in each of two states (Delaware and New Jersey; Day et al., 1992). Subsequently, our limited surveys have found it in a third state (New York), and in seven additional counties (Table 2). Because time has not permitted more extensive field surveys, the range of *P. conradi* is likely larger than depicted in Fig. 2. However, intensive and season-long sampling of *Adelphocoris* nymphs in Warren and Sussex counties in New Jersey from 1981–1996 (Day, unpubl.) has not detected *P. conradi* there, so it is not present in all counties between the original establishment point in northern Delaware and the 1993 recoveries in southeastern New York (Fig. 2). We have not sampled to the south, west, or north of Delaware, so nothing is known of its dispersion in those directions, nor of its climatic limits.

Biologies of parasites. To facilitate sampling in the future, key information for the three native and two introduced species of parasites is provided in Table 3. The dates that each wasp occurs in the field vary with cumulative temperature, and with dates of mowing the alfalfa (early mowing and short mowing intervals each reduce mirid numbers, so indirectly reduce parasite numbers later). Abundance of the preferred mirid host also varies with the plant species (for example, new fields planted to only

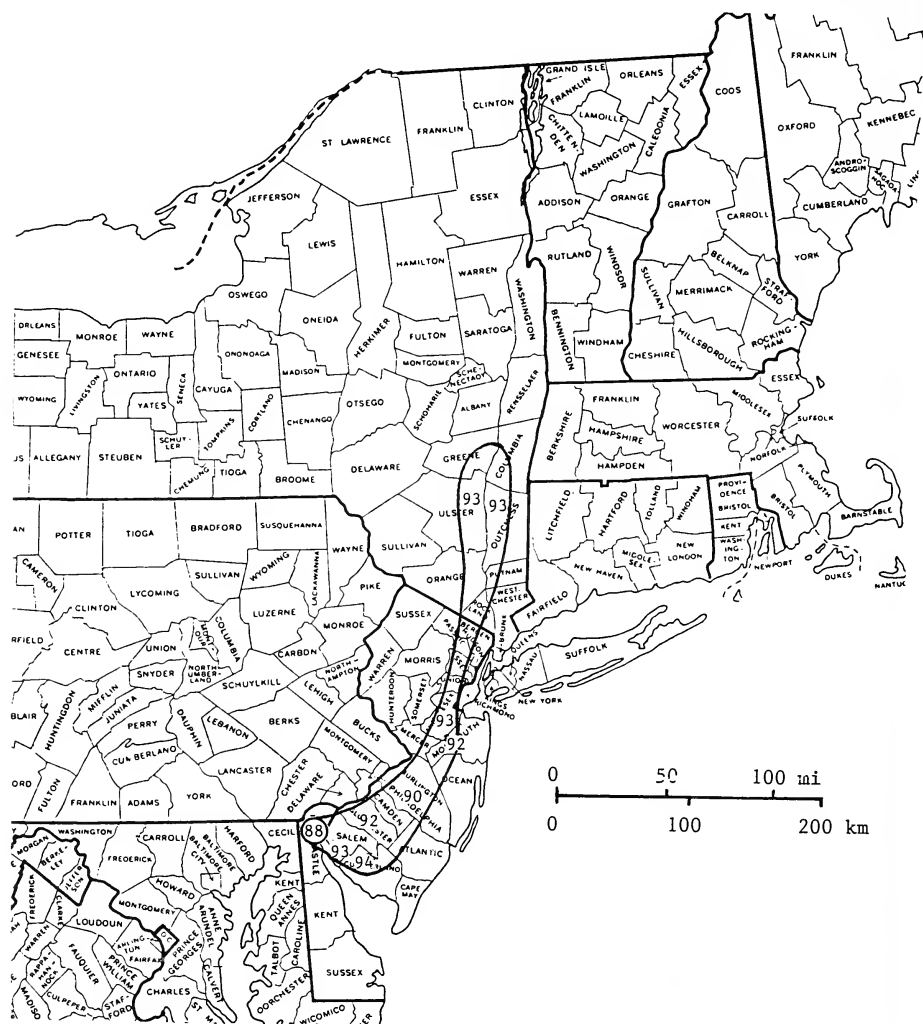


Fig. 2. Known dispersion of *Peristenus conradi*, March 1997. The circled date shows the location and year where this parasite was first found to be permanently established in North America. Uncircled dates indicate when the parasite was first collected in each county. The line depicts the probable range of this species.

alfalfa will not have any grasses or *Erigeron* [Table 3], so *P. pallipes* and *P. pseudopallipes* will be rare or absent).

The natural spread of *P. conradi* and *P. digoneutis* observed to date suggests that both species will continue to disperse in the northeastern states. The faster dispersion of *P. digoneutis* indicates that at present, ecological studies of this species can be conducted at more locations, and over a greater range of environmental conditions, compared to *P. conradi*.

Table 3. Summary of biologies of braconid parasites of alfalfa and grass-feeding mirids, used to determine appropriate sampling dates and hosts.

Parasite species	Generations			No. sexes	Major association	
	Native	No./yr ^a	Months ^a		Plant	Mirid ^b
<i>Peristenus conradi</i> Marsh		1	May	1 ^c	alfalfa	APB
<i>P. pallipes</i> (Curtis)	+	1	May	2	grasses	GPB
<i>P. digoneutis</i> Loan		2–3	Jun–Aug	2	alfalfa	TPB
<i>P. pseudopallipes</i> Loan	+	1	Jul–Aug	2	Erigeron ^d	TPB
<i>Leiophron uniformis</i> (Gahan)	+	2–3	Jul–Aug	2	alfalfa	GFH

^a Period that parasite larvae and adults are present in the field, at 39°–41°N latitude (determined at two monitoring sites in New Jersey, and one in Delaware).

^b GFH = garden fleahopper, *Halticus bractatus* (Say); APB = alfalfa plant bug, *Adelphocoris lineolatus* (Goeze); TPB = tarnished plant bug, *Lygus lineolaris* (Palisot); GPB = grass plant bugs, *Trigonotylus coelestialium* (Kirkaldy) and *Leptopterna dolabrata* (L.). Two additional species were not significantly parasitized: *Megaloceroea recticornis* (Geoffroy) and *Stenotus binotatus* (F.).

^c Over 99% are female.

^d Fleabane, horseweed (Asteraceae), in or near alfalfa fields.

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REFERENCES CITED

- Day, W. H. 1994. Estimating mortality caused by parasites and diseases of insects: comparisons of the dissection and rearing methods. *Environ. Entomol.* 23:543–550.
- Day, W. H. 1996. An evaluation of biological control of the tarnished plant bug, *Lygus lineolaris* (Hemiptera:Miridae), in alfalfa by the introduced parasite *Peristenus digoneutis* (Hymenoptera: Braconidae). *Environ. Entomol.* 25:512–518.
- Day, W. H., R. C. Hedlund, L. B. Saunders, and D. Coutinot. 1990. Establishment of *Peristenus digoneutis* (Hymenoptera: Braconidae), a parasite of the tarnished plant bug (Hemiptera: Miridae) in the United States. *Environ. Entomol.* 19:1528–1533.
- Day, W. H., P. M. Marsh, R. W. Fuester, H. Hoyer, and R. J. Dysart. 1992. Biology, initial effect, and description of a new species of *Peristenus* (Hymenoptera: Braconidae), a parasite of the alfalfa plant bug (Hemiptera: Miridae), recently established in the United States. *Ann. Entomol. Soc. Am.* 85:482–488.

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CRANEFLY LARVAE (DIPTERA: TIPULIDAE) LIVING IN JELLY MASSES

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Abstract.—The immature stages of the crane fly, *Limonia* (*Geranomyia*) *vitiella* Alexander, are found mostly on the leaves of *Pandanus* in moist habitats in the rain forest on the island of Viti Levu, Fiji. The larva lives within a tube of jelly on the upper leaf surface, emerging to feed on decaying and dead epiphylls, and associated microbes. When mature, it usually moves to the lower leaf surface where a larger mass of jelly is produced, within which it pupates. The jelly protects the immature stages against desiccation, and natural enemies. The species occurred patchily in both space and time.

Working in the forests of Guiana, Hingston (1932:342-3) found the 'pupa' (correctly pharate adult (Stewart and Pritchard, 1982)) of a crane fly (*Geranomyia*) suspended inside a globule of transparent jelly attached near the tip of a palm leaf. He noted that "its appearance was that of a large drop of water about to fall from the end of the palm leaf." The species was later described by Edwards (1934) as *Limonia* (*Geranomyia*) *gelatifex*, which is now considered to be a synonym of *Limonia* (*G.*) *recondita* Alexander (Alexander and Alexander, 1970). Hinton (1973) considered that the 'pupa' in its envelope of hygroscopic mucoprotein undoubtedly mimicked a drop of water. More recently, Grimaldi and Young (1992) found a *Geranomyia* sp. larva in a mass of jelly below a tree leaf in an old coffee plantation in Costa Rica. They bred a female adult, but were unable to identify it to species. They also briefly described and figured the larval head capsule.

Working in Fiji a few years ago, we found transparent masses of jelly somewhat resembling very large raindrops attached to pandanus leaves in the rain forest near Suva on the main island of Viti Levu. The majority of these jelly masses contained larvae or 'pupae' of a crane fly. Adults were bred, and identified by A. M. Hutson as *Limonia* (*Geranomyia*) *vitiella* Alexander. The species was previously known only from male and female type specimens also collected near Suva (Alexander, 1956), and is endemic to Fiji. Nothing is recorded of its habits. We report here some preliminary observations on the biology of the species made intermittently over the period 1984-1989.

OBSERVATIONS

The species was first found in humid valleys near streams in the rain forest near Wailoku, 10 km North of Suva (18°04'S, 178°26'E), and later at Colo-i-Suva a few km away (18°03'S, 178°28'E), and at Nabukavesi Creek (18°08'S, 178°13'E) in similar sites. Most larvae and 'pupae' were collected on the leaves of *Pandanus vitiensis*

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Table 1. Occurrence of immature stages of *Limonia (Geranomyia) vitiella* on upper and lower surfaces of *Pandanus* leaves.

	No. on <i>Pandanus</i> leaf	
	Upper surface	Lower surface
Larva Instars 1-3	11	0
Larva Instar 4	18	4
Pupa	0	2
Pharate adult	2	8

Martelli (Smith, 1979). Portions of these leaves were cut and brought back to the laboratory for observation, and to rear the immature stages. Leaf sections were kept in closed plastic boxes or in large plastic bags to avoid desiccation. Despite many attempts, rearing of the younger larvae proved difficult, and survival through more than two larval instars was not obtained. Final instar larvae, pupae and pharate adults could be reared through to the emergence of the nonpharate adult stage with fewer problems.

The majority of larvae were found on the upper surface (Table 1) of mature leaves of *P. vitiensis* which had a fairly thick growth of epiphylls (bryophytes and algae), rarely on younger leaves. The older larvae could usually be picked out by the jelly mass around them, but younger larvae were often concealed among the epiphylls. Field-collected pupae and pharate adults were more often found on the lower surface of the leaf (Table 1). The difference between larvae and pupae/pharate adults in the leaf surface selected is highly significant ($\chi^2 = 17.6$, $P < 0.001$). In the laboratory, no difference was found between upper and lower surfaces as a pupation site, possibly because of the lack of air movement in the containers in which the larvae were kept. Very occasionally, larvae occurred on the leaves of other (unidentified) species of angiosperm. One larva was found on the frond of a fern, and two hanging in jelly below a twig of *Piper* sp. overhanging a stream. Normally only one larva was found within a single jelly mass, but occasionally two were found at somewhat different stages of development (Fig. 1), one having presumably entered a jelly mass already available. No antagonistic interactions between the larvae were observed in this situation.

In all larval instars, the body normally has a covering of a transparent hygroscopic jelly-like substance, probably a mixture of mucoproteins, and thought to be secreted by the salivary glands. The covering of the early instar larvae is thin, and when they are kept in a saturated atmosphere, may apparently be absent. A thicker jelly covering is found in later instars, but a large jelly mass is made only by the mature larva before pupation. If the leaf becomes dry, the jelly is evident as a transparent tube around the larva. In such conditions, the larva becomes inert within the tube, but seems to be fairly resistant to desiccation. If provided with water, it revives and moves around again within a few minutes.

A larva may remain in one place for several days, apparently feeding around the ends of the tube, but more usually the larvae move around, particularly at night, to feed on the decaying and dead tissues of the epiphylls on the leaf surface, and on the microbial flora found there and on the leaf surface. Like most tipulid larvae

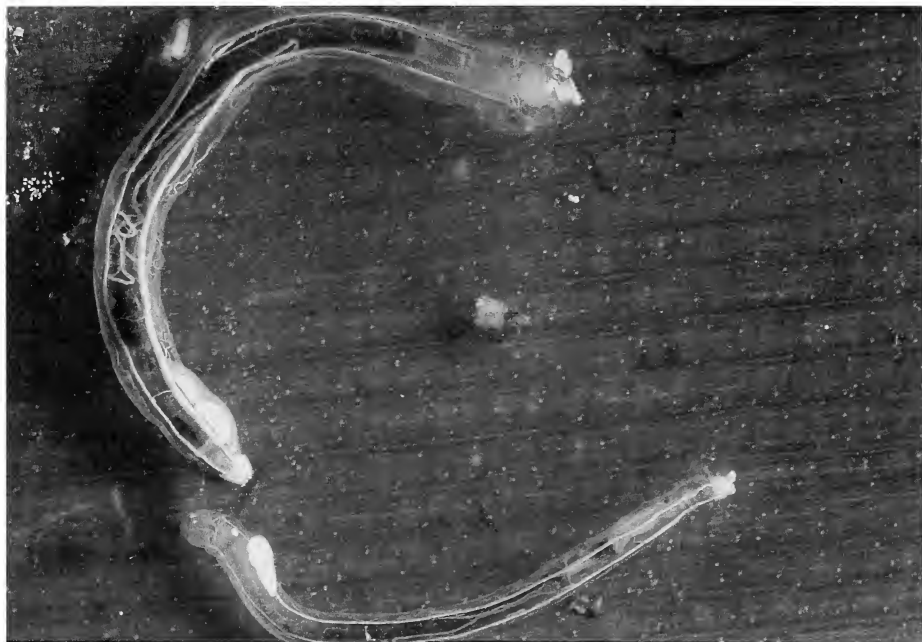


Fig. 1. Two larvae of *Limonia (Geranomyia) vitiella* at different stages of development within the same jelly mass on a leaf of *Pandanus vitiensis*.

(Pritchard, 1983), the larvae are saprophagous, and were not observed to eat the healthy tissues of either the epiphylls or the pandanus leaf. The only potential natural enemy observed was a dolichopodid larva (Diptera) among the epiphylls and detritus near the midrib of a *Pandanus* leaf.

The larva can respire in its jelly covering using the hind pair of spiracles. These normally remain at the air-jelly interphase allowing air to enter the tracheal system, but can be withdrawn from the surface if the larva is disturbed. The tracheae in the thoracic region are pink in colour, and the tracheal system is visible through the transparent tissues of the body wall, as are the gut and malpighian tubules (Fig. 1).

When fully grown, the larva usually moves to the underside of the leaf. It voids its gut, and then produces around itself a larger, thicker and more viscous mass of jelly measuring 1.0–1.5 cm across and 0.5–0.7 cm in thickness. The total length of larval life is not known. Larvae lived up to 3 weeks in the laboratory, during which time only one moult was observed. The larva spends less than one day as a pharate pupa before moulting the last larval skin, which remains in the jelly, to become a pharate adult within the pupal cuticle. The pharate adult stage is also very brief, no more than 2–3 days. The pharate adult is greenish in colour. It respire through prothoracic respiratory horns, which open at the surface of the jelly. It is fairly mobile within the jelly and can wriggle vigorously if disturbed. The nonpharate adult pushes its way partly out of the jelly before emerging from the pupal skin. Equal numbers of male and female adults (14:14) were bred.

In the laboratory, the adults fed on a dilute sugar solution, and may perhaps feed

on nectar or sugary exudates on plant surfaces in the field as do some other Limoniinae (Pritchard, 1983). It was not possible to mate the fragile adults in the laboratory. Eggs have not been found, but are presumably laid among the epiphylls on the *Pandanus* leaves. The maximum length of life of a female adult in the laboratory was 6 days.

DISCUSSION

The species seems to be largely confined in its breeding sites to areas of *Pandanus* growing near the sides of streams in narrow, steep-sided valleys within the rain forest. In this situation, the humidity can remain high enough for the crane fly to complete its life cycle. However, *L.(G.) vitiella* is patchy in its occurrence in both time and space. During dry periods, it appeared to become locally extinct, and presumably recolonized from mountainous areas further from the coast with a more regular rainfall. However, it was absent from many apparently suitable sites even during prolonged wet weather. The localities where we found the species are presumably sink habitats unable to maintain viable populations without immigration from nearby source habitats (Pulliam, 1988; Holt, 1993). Human interference may also restrict its occurrence on a local scale. The mature leaves of *Pandanus* which form its main breeding site are often cut by the local Fijians for making mats of various kinds.

The larvae of *Geranomyia* are mostly aquatic, living in silken tubes, from which they can emerge to feed on exposed surfaces (Alexander and Malloch, 1920; Oldroyd, 1964). The larva of *L.(G.) vitiella* is far more terrestrial in its habits. It has to remain on the exposed upper surface of the leaf because that is where its food is. Epiphylls do not grow on the lower surface. Tipulid larvae are generally very susceptible to desiccation (Pritchard, 1983), and the jelly around the larva clearly helps to protect it from drying out. It is also protected by the epiphylls, which retain water longer than the bare leaf surface, and provide a microhabitat that stays humid provided that rain is not too infrequent. At this stage, the larva can still move away from dry conditions, at least over distances of a few cm. It was noted that larvae tended to move into the groove along the midrib of the leaf. This groove accumulates detritus falling from the trees above, and remains moist longer than other parts of the leaf. The inability of the pupa and pharate adult to move to moister areas probably explains the move of the mature larva to the lower side of the leaf, and the production of a much larger and thicker jelly mass. Below the leaf, they are better protected from the desiccating effect of the sun. The jelly mass also provides protection from predators and parasitoids. The jelly provides a physical barrier to attack, and the greenish pharate adult may also be less visible within it (Grimaldi and Young, 1992). Hinton's (1973) suggestion that the 'pupa' mimics a raindrop—which presumes natural selection of individuals that produce jelly masses more closely resembling raindrops—seems improbable. The resemblance is likely to be fortuitous. Besides the records given above, jelly production is known to occur in one mycophagous species of *Limonia* (Grimaldi and Young, 1992), and these authors suggest that production may be widespread in limoniine tipulids, although in small quantities. Outside the family Tipulidae, Smith (1989) notes the larva of a mycetophilid (*Epicypta* sp.) which lives under a jelly-like 'blob' on rotten wood.

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LITERATURE CITED

- Alexander, C. P. 1956. New or little-known Tipulidae (Diptera). Cl. Oriental-Australasian species. *Annals and Magazine of Natural History*, ser. 12, 9:145-163.
- Alexander, C. P. and M. M. Alexander. 1970. Family Tipulidae, Fasc. 4. *In*: N. Papavero (ed.), A catalogue of the Diptera of the Americas South of the United States. Univ. São Paulo, São Paulo, 259 pp.
- Alexander, C. P. and J. R. Malloch. 1920. Notes on the life history of a crane fly of the genus *Geranomyia* Haliday (Tipulidae, Diptera). *Transactions Illinois State Academy of Science* 13:310-319.
- Edwards, F. W. 1934. Oxford University Expedition to British Guiana, 1929. Diptera Nematocera. *Annals and Magazine of Natural History*, ser. 10, 14:632-635.
- Grimaldi, D. and C. Young. 1992. Observations on the bizarre jelly mass habit of larval *Geranomyia* (Diptera: Tipulidae: Limoniinae). *Journal of the New York Entomological Society* 100:634-637.
- Hinton, H. E. 1973. Natural deception. *In*: R. L. Gregory and E. H. Gombrich (eds.), *Illusion in Nature and Art*. pp. 97-159. Duckworth, London.
- Holt, R. D. 1993. Ecology at the mesoscale: the influence of regional processes on local communities. *In*: R. E. Ricklefs and D. Schluter (eds.), *Species diversity in ecological communities*. pp. 77-88. Chicago University Press, Chicago and London.
- Oldroyd, H. 1964. *The Natural History of Flies*. Weidenfeld and Nicholson, London, 324 pp.
- Pritchard, G. 1983. Biology of Tipulidae. *Annual Review of Entomology* 28:1-22.
- Pulliam, H. R. 1988. Sources, sinks, and population regulation. *American Naturalist* 132:652-661.
- Smith, A. C. 1979. *Flora Vitiensis Nova*, Vol. 1. Pacific Tropical Botanical Garden, Hawaii, 495 pp.
- Smith, K. G. V. 1989. An introduction to the immature stages of British flies. *Handbooks for the Identification of British Insects* 10(14):1-280.
- Stewart, M. and G. Pritchard. 1982. Pharate phases in *Tipula paludosa* (Diptera: Tipulidae). *Canadian Entomologist* 114:275-278.

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TWO NEW BASAL-CLADE THYSANOPTERA FROM CALIFORNIA WITH OLD WORLD AFFINITIES

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Abstract.—*Parrellathrips ullmanae* gen. et sp. nov. is described from California in the Fauriellidae, a family previously known only from southern Europe and South Africa. *Heratythrips sauli* gen. et sp. nov. is described from California in the Adiheterothripidae, a family known only from western USA and the Mediterranean and Indian areas. Cladistic analysis of character states in these and related taxa indicates that the present family classification in the lower clades of the Thysanoptera is not strongly supported.

Of the two sub-orders in the insect order Thysanoptera, the Terebrantia includes the most basal elements and was considered by Mound et al. (1980) to comprise seven families. To these seven, however, should be added an eighth, the Melanthripidae, that was previously regarded as a sub-family of the Aeolothripidae (Bhatti, 1990). Amongst these terebrantian families, members of two of the more basal clades, the Adiheterothripidae and the Fauriellidae, show interesting disjunct distributions. The Adiheterothripidae currently comprises two genera, one monobasic in western north America, and the second with four species from several countries between the Mediterranean and India. The Fauriellidae, in contrast, comprises three genera, two monobasic from south eastern Africa and the third with two species from the Mediterranean area. The purpose of this article is to describe from California two new species, each in a new monobasic genus, and one in each of these two families. These taxa not only emphasise the disjunct geographic distributions within these families, they also present considerable problems for the systematic relationships of the basal clades of the order Thysanoptera. Both taxa were found in the collections of the Entomology Research Museum of the University of California at Riverside during a recent visit (by LAM). This Museum includes an extensive collection of Thysanoptera that was developed by William Ewart, who both mounted and distinguished the two thrips discussed here, along with many other undescribed Californian Thysanoptera species.

Little is known of the biology of the thrips in these basal clades. In Adiheterothripidae, species of the Old World genus *Holarthrothrips* apparently breed in the flowers of the date palm (*Phoenix dactylifera*), whereas adults of its west coast New World relative, *Oligothrips*, have usually been found in the flowers of the ericaceous plant manzanita (*Arctostaphylos*). Host-plant relationships in the Fauriellidae are similarly inconclusive and lacking any pattern. The two European species are possibly associated with a grass or some low growing herb, and although both sexes of one of the two South African species were taken from *Elytropappus* (Asteraceae), the only known specimens of the other were taken from an unidentified tree. In contrast,

females and larvae of the new fauriellid from California described below were found in the flowers of a native *Garrya* (Garryaceae).

The new Californian fauriellid described below has a well developed tentorial bridge, although this structure has been lost in the other Fauriellidae. Conversely, the new Californian adiheterothripid lacks a tentorial bridge, whereas other members of this family are reported to retain this structure in its plesiomorphic condition (Mound et al., 1980). Phylogenetic relationships between these and some other thrips taxa in lower clades are therefore explored below.

FAMILY FAURIELLIDAE

This family is not characterised by any single apomorphy, the four genera involved showing a confusing pattern of character states that are intermediate between the states found in several other families. The antennae and their sensoria are similar to those found in the Merothripidae and the Melanthripidae, in that there are nine (rarely eight) antennal segments of which most bear numerous microtrichia, and the third and fourth segments have the sensoria forming a transverse apical band. The new fauriellid species described below retains a complete tentorial bridge as in the Merothripidae, Aeolothripidae and Melanthripidae, although this structure is lost in the previously described species of Fauriellidae as well as in all species of Thripidae. The forewings of fauriellids are slender as in the Thripidae, but cross veins are commonly visible between the costa and the first vein, a plesiomorphic condition that is particularly well developed in the broad wings of members of the Aeolothripidae and Melanthripidae. Finally, the chaetotaxy of the head and also of the seventh abdominal sternite is essentially similar to that found in Thripidae rather than to that found in the more basal taxa.

Within the Fauriellidae, the five known species show an interesting diversity in structure. In the South African *Opisthothrips elytropappi* Hood the posterior abdominal segments and ovipositor are very weakly developed, indicating that this species cannot cut into plant tissue to insert its eggs but must instead deposit them superficially, presumably within the florets of its Asteraceae host. In contrast, the ovipositor and terminal abdominal segments of the new Californian species are exceptionally long. Four of the known species retain the plesiomorphic condition of the maxillary palps with three segments, but the two European species comprising *Ropotamothrips* sometimes have only two maxillary palp segments. These two species are particularly similar to each other, although one has long pronotal posteroangular setae whereas the other has these setae short. The differences between the four recognised genera are summarised in the key below.

KEY TO GENERA OF FAURIELLIDAE

1. Median abdominal tergites each with only two pairs of discal setae, third pair of discal setae arising lateral to pleurotergal sutures (Fig. 5); tergites completely reticulate medially, with transverse reticulations; sternite VII with only 2 pairs of major setae, the lateral pair greatly reduced (Fig. 10); forewing with 2 cross veins clearly visible between costa and first vein; forewing posterior fringe cilia distinctly undulating; maxillary palps sometimes with only 2 segments *Ropotamothrips*
- Median abdominal tergites each with three pairs of discal setae, third pair of discal

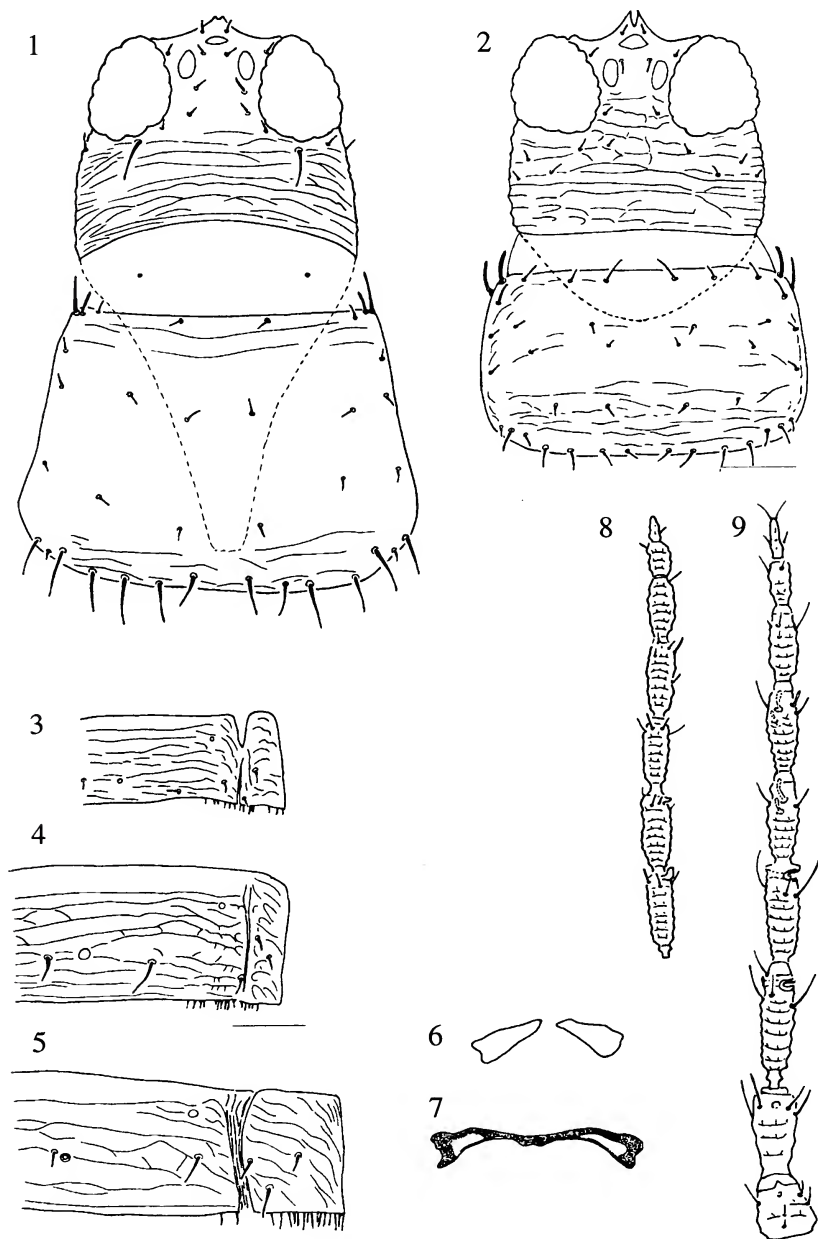
- setae arising mesad of pleurotergal sutures (Fig. 3); tergites with median reticulation weak or almost absent; sternite VII with 3 pairs of setae (Figs. 11–13); forewing with cross veins weak or absent between costa and first vein; forewing posterior fringe cilia straight or almost straight; maxillary palps with 3 segments 2
2. Prosternal ferna fused medially (Fig. 7); head with tentorial bridge complete medially; forewing second vein with 8 to 10 setae; sternite VII median setae (B1) at margin, setae B2 and B3 arising in front of posterior margin (Fig. 13); antennal segment III almost 4.0 times as long as maximum width (Fig. 9) *Parrellathrips*
- Prosternal ferna separated (Fig. 6); head with tentorial bridge not visible; forewing second vein with 3 to 5 setae; sternite VII setae arranged differently; antennal segment III 2.0 times as long as wide or shorter 3
3. Antennae with 8 segments; sternite VII sclerotised area reduced to a narrow transverse band bearing three pairs of setae close together (Fig. 11); metanotum with neither setae nor pores near posterior margin; ovipositor very weak; forewing second vein with 3 setae *Opisthothrips*
- Antennae with 9 segments; sternite VII fully sclerotised, median setae arise well in front of posterior margin (Fig. 12); metanotum with one pair of pores and one pair of setae near posterior margin; ovipositor not reduced; forewing second vein with 5 setae *Fauriella*

Parrellathrips, new genus

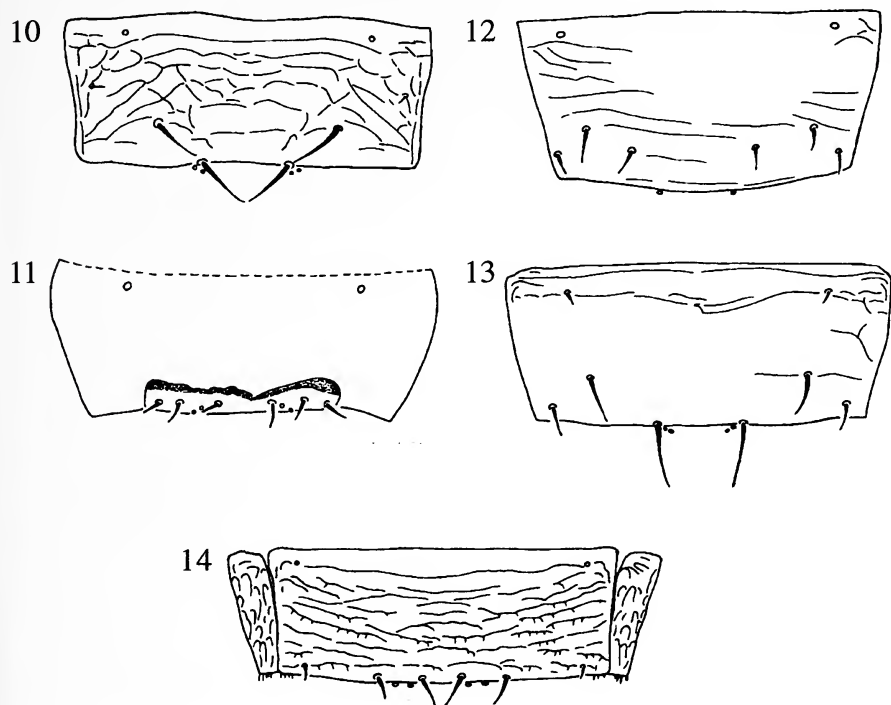
Description. *Antennae* 9-segmented (Fig. 9); I with one pair of median dorsal setae, II without microtrichia, III–IX with 1 to 5 transverse rows of microtrichia, III and IV each with a subterminal broadly transverse sensory area.

Head with compound eyes smaller ventrally than dorsally, without pigmented facets or enlarged facets; tentorial bridge clearly developed, although weak medially; maxillary palps 3-segmented; mouth cone extending between and beyond fore coxae (Fig. 1).

Pronotum with posteromarginal setae not more than twice as long as discal setae (Fig. 1); mesonotum with no median discal setae; metanotum with one pair of setae at anterior margin and one pair near posterior margin; prosternal ferna joined medially; spinasternum deeply boat-shaped; mesopre-episternum not fused; mesothoracic spiracular areas elongate dorsoventrally. Mesothoracic furca well developed as a median spinula, metafurca without a spinula. Metathoracic sterno-pleural sutures well developed. Tarsi each with 2 segments; fore tarsus with sharply recurved hamus not extending to a stout seta as in Aeolothripidae. Forewing with apex pointed; posterior cilia straight but slightly wavy near their apices; veinal setae increasing in length to wing apex, second vein with about 10 setae. Tergites VI and VII with median setae about 0.5 as long as median length of tergite, lateral discal seta present just mesad of tergo-pleurotergal suture; pleurotergites each with one discal seta, pleurotergites II–IV posterior margin with fringe of microtrichia; tergite VIII posterior margin slightly emarginate medially with no marginal comb, median setae extending beyond posterior margin; tergite X longer than median length of tergite VIII. Sternites with 3 pairs of primary (marginal) setae, no discal setae; sternite VII with B2 and B3 arising sub-marginally, B1 arising at margin, adjoining bases of setae B1 are two pairs of minute pores presumably representing bases of vestigial setae of sternite VIII (Fig. 13). Ovipositor long and well developed, extending be-



Figs. 1-9. 1. Head and pronotum, *Parrellathrips ullmanae*. 2. Head and pronotum, *Heratythrips sauli*. 3. Tergite IV, *Opisthothrips elytropappi*. 4. Tergite VI, *Heratythrips sauli*. 5. Tergite IV, *Ropotamothrips*. 6. Prosternal ferna, *Fauriella natalensis*. 7. Prosternal ferna, *Parrellathrips ullmanae*. 8. Antennal segments III-IX, *Heratythrips sauli*. 9. Antenna, *Parrellathrips ullmanae*.



Figs. 10–14. Sternite VII. 10. *Ropotamothrips buresi*. 11. *Opisthothrips elytropappi*. 12. *Fauriella natalensis*. 13. *Parrellathrips ullmanae*. 14. *Heratythrips sauli*.

yond apex of abdomen, weakly curving downward at apex. Type-species *Parrellathrips ullmanae* sp.n.

Discussion. This new genus and species is named in recognition of the outstanding work on the biology of pest Thysanoptera by the research teams at the University of California at Davis led by Michael Parrella and Diane Ullman. The genus is evidently closely related to other members of the family Fauriellidae, but is remarkable for the retention of the tentorial bridge in the head. Relationships to the other taxa in this family are discussed further below.

Parrellathrips ullmanae, new species

Description. *Macropterous female.*

Color: Body, legs and antennae mainly medium brown; all tarsi yellow; antennal segment II yellow at apex, III yellowish washed with pale brown, IV slightly paler than V–IX; fore tibiae yellow but variably washed with brown; major setae not dark; forewing lightly shaded, but with extreme apex dark.

Structure: Head slightly produced medially between antennal bases (Fig. 1), this extension deeply cleft medially; median dorsal length of head less than width across

compound eyes, median ventral length about equal to width across compound eyes, mouth cone long and extending between fore coxae [head apparently deep dorso-ventrally near posterior margin, thus width of head at posterior margin broader in slide-mounted specimens due to coverslip pressure]; three pairs of ocellar setae present, pair III on a line between anterior margins of hind ocelli; postocular setae forming an arched row of 5 setae dorsally; compound eyes not prolonged ventrally; tentorial bridge complete but weakly sclerotised medially, anterior tentorial arms not developed; maxillary palps with 3 segments; mandible with very broad base, but ventral surface of head not as asymmetric as in many Aeolothripidae; mouth cone long, reaching beyond fore coxae to prosternal ferna.

Antennae with 9 segments (Fig. 9), segments III and IV both more than 3.0 times as long as wide, and both with a broad transverse sensory area ventrally at apex; V–VIII with one ventral, sub-terminal sense cone, V–VI with one smaller lateral sense cone; segment I with one pair of median mid-dorsal setae.

Pronotum with notopleural sutures visible only in lateral view; dorsal surface weakly sculptured near anterior and posterior margins; anterior margin with 1 pair of submedian setae, and 2 or 3 setae near anterior angles; posterior margin with 1 pair of median setae arising just in front of margin, 2 or 3 pairs of marginal setae, and 3 pairs of posteroangular setae of which the median pair is very small (Fig. 1). Mesonotum with 2 pairs of setae near posterior margin. Metanotum reticulate medially, with 1 pair of setae at anterior margin, 1 pair of setae and 1 pair of campaniform sensilla near posterior margin; metascutellum almost as long as metascutum.

Prosternal ferna well developed and joined medially (Fig. 7). Spinasternum large, deeply boat shaped but with an acute process postero-medially. Mesothoracic preepisternum variable, usually completely distinct but sometimes weakly fused ventro-medially.

Tibiae with 1 or 2 moderately developed stout apical setae. Forewing not broad, tapering to a point; cross veins weakly developed; clavus with 5 marginal setae; first vein with 3 setae and 1 campaniform sensillum near base, then 3 setae before cross vein, followed by about 9 setae to apex; second vein with 1 seta basal to cross vein, then about 9 setae in distal row to apex; these setae increasingly longer toward wing apex; fringe cilia straight but with extreme apices weakly undulating.

Abdominal tergite I with about 4 transverse lines of sculpture, 1 pair of campaniform sensilla medially and 1 pair of minute setae laterally; tergites II–VIII with 2 pairs of discal setae, median pair mesad of median campaniform sensilla, with almost no sculpture and no microtrichia; tergite X elongate, with median split extending 0.3 from posterior margin, without paired trichobothria. Ovipositor valves weakly curving downward, extending slightly beyond abdominal apex. Sternites III–VI each with 3 pairs of marginal setae, II usually with only 2 pairs and with 3 pairs of small setae near anterior margin; sternite VII (Fig. 13) B1 setae long and arising at margin, B2 setae far anterior of margin, B3 slightly anterior of margin; two pairs of minute pores close to base of B1 setae probably represent bases of vestigial setae of sternite VIII.

Measurements (holotype female and smallest paratype, in microns): Body length 1750 (1500). Head, dorsal length 110; ventral length of head capsule 125; total ventral length to apex of mouth cone 290; width of head across compound eyes 130. Pronotum, length 150; maximum width 210; longest posterior seta 30. Forewing, length 1100; median width 70; length of basal and distal setae on first vein 30, 60.

Length of median setae on tergites II, VIII, IX and X—8, 35, 70, 30; median length of tergites VII, VIII, IX and X—85, 65, 85, 120. Antennal segments I–IX length 25, 50, 75, 60, 50, 50, 45, 30, 25.

Larva II: Head small in relation to large body, legs not elongate. Antennal segment V subequal in length to segment IV or slightly longer, III–VII each with 3 or 4 rows of microtrichia. Pronotum with 7 pairs of setae. Tergite IX posterior margin with 4 stout tubercles of which the median pair extends beyond midpoint of tergite X; abdominal spiracles very small, scarcely wider than a setal base. Sternites each with 3 pairs of setae.

Material examined. Holotype, ♀, USA, California, Riverside County, Mountain Center, in flowers of *Garrya vealchii* at 4000 ft., 20.1.1983, R. K. Velten, (CAS). Paratypes: USA, California: 2 ♀ and 6 instar II larvae, collected with the holotype; also 17 females with identical data except 6.1.1983, J. Pinto, (UCR; CAS; USNM; NHML).

Discussion. Because of the shape of the head, which is deeper at the posterior part than anteriorly, several of the paratypes have the head crushed and orientated laterally. This makes the tentorial bridge difficult to observe, but even in the smallest paratype the full transverse length of this structure can be traced. The species is remarkable for its large size, with the antennae, ovipositor and tenth abdominal segment being particularly long. The presence of larvae indicates that the species was breeding on *Garrya vealchii*, and the stout posterior spines of the larvae suggest that they pupate in the soil. Members of the Garryaceae are found particularly in California, but the family extends to Mexico and the Caribbean.

FAMILY ADIHETEROTHRIPIDAE

The genus *Adiheterothrips* Ramakrishna is a junior synonym of *Holarthrothrips* Bag-nall, but is available and has priority as the root for the family name. All members of this family have a curious conical sensorium on the third and fourth antennal segments. A similar sensorium is known from the antennae of the members of the Stenurothripidae, a family known only from fossils (Schliephake, 1990). Other character states are varied between the three genera recognised here, and these can be distinguished by means of the following key.

KEY TO GENERA OF ADIHETEROTHRIPIDAE

1. Forewing second vein with no setae on basal stem; sternites with 3 pairs of postero-marginal setae scarcely twice as long as marginal microtrichia; fore tarsus without a recurved ventral hamus; head and pronotum lacking setae longer than median length of one posterior ocellus (Fig. 2); tentorial bridge not developed *Heratythrips*
- Forewing second vein with 2 or more setae basal to cross vein between first and second veins; sternites with posteromarginal setae prominent, usually 4 pairs present; fore tarsus with well-developed recurved ventral hamus; head or pronotum usually with at least one pair of setae twice as long as a posterior ocellus; tentorial bridge usually present 2
2. Sternite VII usually with 4 pairs of setae, one pair arising on posterior margin medially, one pair arising close to these but in front of margin, 2 pairs arising laterally far in front of posterior margin; sternites IV–VI without discal setae; tergites VII and VIII

- without any posteromarginal microtrichia; metanotal sculpture reticulate or elongate reticulate, without microtrichia *Oligothrips*
- Sternite VII with 4 (or 3) pairs of posteromarginal setae and about 3 pairs of discal setae laterally; sternites IV–VII often with discal setae laterally; tergites VII and VIII with complete posteromarginal comb of microtrichia; metanotum with concentric rings of sculptured lines bearing numerous microtrichia *Holarthrothrips*

Heratythrips, new genus

Description. *Antennae* 9-segmented (Fig. 8); I with one pair of median dorsal setae, II–IX each with up to 8 transverse rows of microtrichia, III and IV each with a small conical sense cone at apical external margin.

Head with eyes equal in size dorsally and ventrally, with no pigmented nor enlarged facets; tentorial bridge not visible; maxillary palps 3-segmented; mouth cone not reaching fore coxae; dorsal surface without long setae, 3 pairs of ocellar setae present, postocular setae form an irregular row of about 5 setae dorsally.

Pronotum with posteromarginal setae not more than twice as long as discal setae; mesonotum with no median discal setae; metanotum with one pair of setae at anterior margin and one pair near posterior margin; prosternal ferna slender but joined medially; spinasternum deeply boat-shaped; mesopre-episternum not fused; mesothoracic spiracular areas elongate dorsoventrally. Mesothoracic furca well developed as a median spinula, metafurca without a spinula. Metathoracic sterno-pleural sutures well developed. Tarsi each with 2 segments; fore tarsus without a recurved hamus. Forewing with apex pointed; posterior cilia straight but slightly wavy near their apices; veinal setae very small, gradually increasing in length to wing apex, second vein with about 5 setae.

Tergites VI and VII with transverse lines of sculpture medially, each tergite with fine microtrichia on the lines of sculpture laterally, and posterior margins with a comb of microtrichia laterally on II–VII; median setae less than 0.3 times as long as median length of tergite, lateral discal seta present just mesad of tergo-pleurotergal suture (Fig. 4); pleurotergites II–VII each with one discal seta and a posteromarginal fringe of microtrichia; tergite VIII without a marginal comb, median setae not extending to posterior margin; tergite X not longer than median length of tergite IX. Sternites IV–VII with 3 pairs of marginal setae but no discal setae (Fig. 14); ovipositor well developed and curving downward at apex. Type-species *Heratythrips sauli* sp.n.

Discussion. This new genus and species is named in recognition of the support given by John Heraty and Saul Frommer to the senior author's studies on thrips whilst visiting the magnificent collections developed by Bill Ewart at the University of California, Riverside. Related to *Oligothrips* and *Holarthrothrips* by the presence of a distinct but small conical sense cone on the third and fourth antennal segments, it is distinguished in the key to genera above. As in *Holarthrothrips*, it retains the plesiomorphic chaetotaxy of sternite VII with three pairs of setae at the posterior margin (Fig. 14), and the tergites have a marginal fringe of microtrichia laterally (Fig. 4). But the basal stem of the second vein of the forewing does not bear any setae, the metanotum lacks microtrichia, and the tentorial bridge is not visible. The relationships of this genus are discussed further below.

Heratythrips sauli, new species**Description.** *Macropterous female.*

Color: Body mainly brownish yellow, tibiae darker, antennal segments II–IX brown; forewings pale, but with extreme apex dark.

Structure: Head slightly produced medially between antennal bases (Fig. 2), this extension deeply cleft medially; median dorsal length of head less than width across cheeks; three pairs of ocellar setae present, pair III on a line between anterior margins of hind ocelli; postocular setae forming an irregular row of 5 setae dorsally; compound eyes not prolonged ventrally; tentorial bridge not visible; maxillary palps with 3 segments; mandible with broad base; mouth cone short and not reaching fore coxae.

Antennae with 9 segments (Fig. 8), segments III and IV both about 2.5 times as long as wide, and both with a small oval bud-like sense cone at apex, V–VII each with a slender sense cone near apex; segment I with one pair of median mid-dorsal setae.

Pronotum without long setae, dorsal surface very weakly sculptured near anterior and posterior margins; anterior margin with 1 pair of submedian setae, and 2 or 3 longer setae near anterior angles; posterior margin with about 6 pairs of setae of which 2 or 3 pairs of posteroangulars are longest (Fig. 2). Mesonotum with 2 pairs of setae near posterior margin. Metanotum reticulate medially, with 1 pair of setae at anterior margin, 1 pair of setae and 1 pair of campaniform sensilla near posterior margin; metascutellum two-thirds as long as metascutum. Prosternal ferna slender but joined medially. Spinasternum large, deeply boat-shaped. Mesothoracic pre-episternum apparently weakly fused ventro-medially.

Hind tibiae with 1 or 2 moderately developed stout apical setae. Forewing not broad, tapering to a point; cross veins weakly developed; clavus with 5 marginal setae; first vein with 3 setae and 1 campaniform sensillum near base, then 3 setae before cross vein, followed by 5 to 7 setae to apex; second vein with 1 seta basal to cross vein, then 5 or 6 setae distally to apex; these setae are scarcely twice as long as the veinal microtrichia near wing base, increasingly longer toward the wing apex; fringe cilia straight with extreme apices faintly wavy. Abdominal tergite I with about 4 faint lines of sculpture, 1 pair of campaniform sensilla medially and 1 pair of minute setae laterally; tergites II–VII with 3 pairs of discal setae, median pair mesad of median campaniform sensilla, with several lines of sculpture medially, posterolateral margins with a fringe of microtrichia (Fig. 4); tergite VIII without marginal microtrichia and median setae extending just beyond posterior margin; tergite X not elongate, with median split extending 0.3 from posterior margin, without paired trichobothria. Ovipositor valves down-curved, not extending beyond abdominal apex. Sternites III–VII each with 3 pairs of marginal setae; sternite II with 2 pairs of marginal setae and 3 pairs of small setae near anterior margin; sternite VII with two pairs of minute pores close to bases of median setae probably representing bases of vestigial setae of sternite VIII (Fig. 14).

Measurements (holotype female in microns): Body length 1250. Head, length 100; width 145. Pronotum, length 100; width 170; longest posterior seta 15. Forewing, length 800; median width 60; length of basal and distal setae on first vein 10, 15,. Length of median setae on tergites II, VIII, IX and X 10, 15, 50, 50; median length

of tergites VII-X 75, 75, 60, 60. Antennal segments I-IX length 13, 35, 40, 40, 38, 40, 35, 25, 13.

Material examined. Holotype, female, USA, California, San Bernadino County, Providence Mts, 6 miles S.E. Kelso Dune, ex *Coleogyne*, 27.4.1968, W. Ewart (CAS). Paratype: USA, California: 1 female collected with the holotype (UCR).

Discussion. Although two females were taken together, this cannot be taken as evidence that the host plant of the species is *Coleogyne* nor even any other member of the family Rosaceae.

Holarthrothrips Bagnall

Bhatti (1986) included four species in this genus. Curiously, all four of these species have been taken from the inflorescences of *Phoenix dactylifera*, the date palm, but the differences between them seem unlikely to represent population variation within a single species. For example, the Indian species *H. jambudvipae* lacks any elongate pronotal setae unlike the other three species; *H. josephi* from Iraq has a postero-marginal comb of microtrichia on most abdominal tergites whereas this is found only on tergites VII and VIII in the other species; *H. tenuicornis* and *H. jambudvipae* both apparently lack sternal discal setae, and both have paired mesothoracic sternopleural sutures, in contrast to the other two species. This variation in structural detail, despite the general uniformity of body form within the genus, coupled with the common host plant, is a remarkable example of intra-generic radiation. The structure of the abdomen is particularly similar to that of species of the family Heterothripidae.

Oligothrips Moulton

Only one species has been described in this genus, *O. oreios* Moulton (1933), and material has been studied from many parts of California, from Shasta and Nevada Counties in the north to Riverside and San Bernardino Counties in the south. In addition, one female has been studied from Utah, Washington County, one female and one male from an unspecified locality in Oregon, and a series of both sexes from *Actostaphylos* flowers at an unspecified locality in Arizona. Three females from Grass Valley, Nevada County, the type locality in California, have the head longer than wide, the ocellar setae sufficiently long to extend beyond the posterior margin of the hind ocelli, the anteromedian pair of pronotal discal setae more than 2.0 times as long as the minor discal setae, and the metanotal sculpture with elongate, linear reticulation. Unfortunately, the holotype itself is so poorly prepared that the condition of the first three characters cannot be confirmed, although the metanotal sculpture agrees with the above description. Specimens studied from most other Californian localities have the metanotal sculpture similar, but the ocellar setae are shorter and do not extend to the posterior margin of the hind ocelli, and the anteromedian pronotal discal setae are scarcely 1.5 times as long as the minor discal setae. In contrast, the single female from Utah has the ocellar setae no longer than the length of one ocellus, the pronotal discal setae are all small and equal in size, and the metanotal reticulation is almost equiangular. The specimens from Arizona are intermediate in structure between those from California and the female from Utah. However, the male and female specimens from Oregon are smaller in size with the head shorter

Table 1. Data set for nine genera of Thysanoptera.

<i>Damerothrips</i>	00001000001000000000
<i>Opisthothrips</i>	11000011100000001011
<i>Parrellathrips</i>	00000100100000001010
<i>Ropotamothrips</i>	10010011101100000110
<i>Oligothrips</i>	00200100010002010010
<i>Holarthrothrips</i>	00200100010002020010
<i>Heratythrips</i>	10201100110001000010
<i>Heterothrips</i>	10100100010012121010
<i>Fauriella</i>	10000100100000001010

and broader, all the setae distinctly shorter, and the metanotum reticulate. In all of the available Californian specimens the sternites bear numerous microtrichia, whereas the females from Arizona, Utah and Oregon lack microtrichia on the sternites, although these structures are present on the male from Oregon. It is possible that the available Californian specimens represent one species, *O. oreios* Moulton, but that the specimens from Arizona, Utah and Oregon represent further undescribed species. The most curious difference between these samples is that a tentorial bridge is visible in the specimens from Grass Valley, and is dark brown and very obvious in the Arizona specimens, but is not visible in the other specimens, suggesting that the sclerotisation of this structure is variable between populations.

SYSTEMATIC RELATIONSHIPS

As indicated in the Introduction, both of the new taxa described here differ in at least one important character state from other members of the two families in which they are placed. Moreover, the family Fauriellidae is not defined on any single apomorphy, but comprises a group of species in which several character states are intermediate between those found in other recognised families. Even the second instar larvae of *Parrellathrips ullmanae* that are described above, the only larvae known for any Fauriellidae, have no apomorphies by which they can be distinguished from larvae of related families. In the key to larvae by Heming (1991) the *Parrellathrips* larvae run to the family Aeolothripidae but have shorter antennae than members of that family.

Because of the difficulties outlined above, a data matrix of character states was compiled for all genera of the Fauriellidae and Adiheterothripidae together with *Heterothrips* of the Heterothripidae, and including *Damerothrips* of the Merothripidae as out-group (Tables 1, 2). This was then analysed under parsimony using Hennig86 (Farris, 1988) operating under the Microsoft Windows shell Tree Gardener 1.0 (Ramos, 1996). These analyses produced results that are significant to the recognition of the families Adiheterothripidae and Fauriellidae, and also to the relationship between these groups and the Heterothripidae.

The Hennig86 option used, an exact tree search (option ie) with all characters additive, produced three trees (length 32, CI .625). The single tree retained after successive weighting (Fig. 15) supported neither Fauriellidae nor Adiheterothripidae as a clade. Various other weight and character type options were tried, but almost

Table 2. Character states for nine genera of Thysanoptera.

Tentorial bridge:	0—complete; 1—absent.
Number of antennal segments:	0—9; 1—<9.
Sensoria on antennal segments III and IV:	0—transverse and simple; 1—transverse and porous; 2—emergent and conical.
Maxillary palp segments:	0—3 present; 1—2 present.
Fore tarsal recurved hamus:	0—present; 1—absent.
Prosternal ferna:	0—separate; 1—fused medially.
Metanotal campaniform sensilla:	0—1 pair present near posterior; 1—absent.
Metanotal posterior setal pair:	0—present; 1—absent.
Forewing second vein basal to cross vein:	0—with setae; 1—without setae.
Forewing cross veins between costa and first vein:	0—2 visible; 1—0 visible.
Forewing posterior fringe cilia:	0—straight; 1—undulating.
Median abdominal tergites with:	0—2 discal setae laterally; 1—1 discal seta laterally.
Tergite IV median setae:	0—wider apart than their length; 1—long and close together.
Tergite IV with marginal comb posterolaterally:	0—absent; 1—present but short; 2—present long and slender.
Pleurotergal sutures:	0—present; 1—absent.
Median sternites:	0—with no posteromarginal fringe; 1—with short posteromarginal fringe; 2—with long fringe.
Sternite VII marginal setae:	0—arising at margin; 1—one or more pairs in front of margin.
Sternite VII setae:	0—3 or more pairs; 1—2 pairs.
Sternite VIII:	0—present as paired lobes; 1—absent.
Ovipositor valves:	0—normal; 1—greatly reduced.

all similarly failed to find support for either family. In Fauriellidae, *Opisthothrips* and *Ropotamothrips* consistently were placed together, although at bootstrap score below the conventional critical value. *Parrellathrips* and *Fauriella* mostly were placed as a sister-group to a clade comprising Adiheterothripidae plus Heterothripidae. Bootstrap scores in the original analysis were 0.63 for *Opisthothrips* + *Ropotamothrips*, and 0.72 for Adiheterothripidae + Heterothripidae. *Heterothrips* was placed as sister to *Holarthrothrips* in some trees, but as sister to *Holarthrothrips* plus *Oligothrips* in others.

The position on the tree of *Heterothrips* relative to the three genera comprising the Adiheterothripidae is particularly interesting. In effect, the Adiheterothripidae is defined on just one character—the presence of a conical sensorium on antennal segments three and four. However, this character state is also found in several closely related Baltic Amber fossils placed in the fossil family Stenurothripidae (see Schliephake, 1990); it is thus plesiotypic within this lineage and may indicate an ancient and previously widespread group. In contrast, the Heterothripidae have the sensoria on antennal segments three and four forming a circumpolar porous band, and members of this family are restricted to the New World. Homoplasy between the antennal sensorial structure of the Adiheterothripidae and Heterothripidae is inconceivable, but the possibility exists that the Heterothripidae is a relatively new lineage that developed only after the separation of the New World continent from the Old World. In contrast, Mound et al. (1980) placed this family as the sister group of the Fauriellidae, a suggestion for which there is now little support.

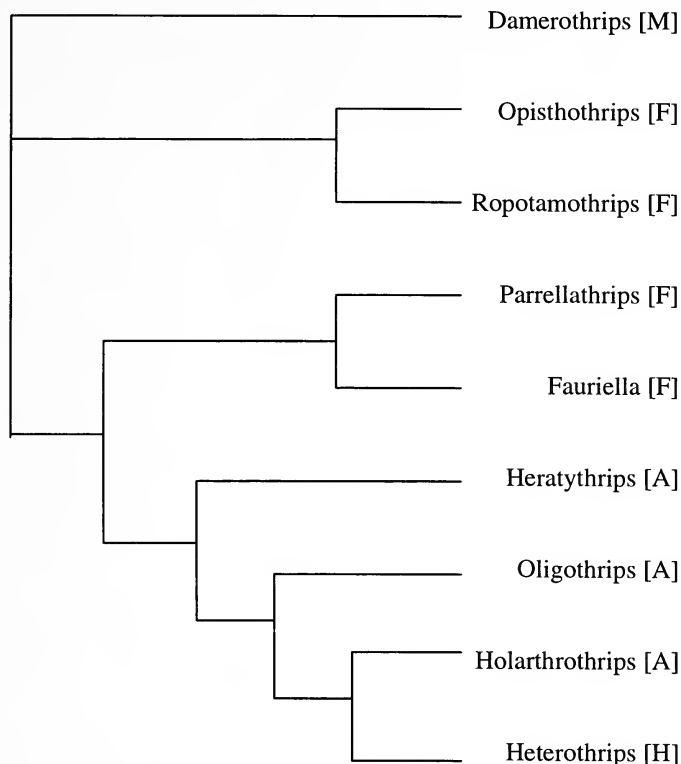


Fig. 15. Computed relationships between nine genera of Thysanoptera (Hennig86 "ie" with successive weighting) [A] = Adiheterothripidae; [F] = Fauriellidae; [H] = Heterothripidae; [M] = Merothripidae.

Relationships between the four genera now placed in the Fauriellidae are as unresolved as the significance of the family itself. *Opisthothrips* from southern Africa and *Ropotamothrips* from southern Europe are associated on the tree (Fig. 15) only through 'loss apomorphies' on the metanotum. Similarly, *Parrellathrips* from California is associated with *Fauriella* from southern Africa only by the chaetotaxy of sternite seven which is probably due to homoplasy.

The problem with defining lineages within the Thysanoptera arises partly from the high levels of homoplasy exhibited in many character states, but also from the frequency that 'loss apomorphies' are employed to define groups in this order of insects. For example, presence of a tentorial bridge is a plesiomorphy, but loss of this structure could well arise through the action of non-homologous mutations, and evidence given above suggests that this structure is variably developed within the genus *Oligothrips* and possibly within species of that genus. Similar problems arise with loss of veins in the forewings, or loss of setae on these veins, or the loss of setae on the posterior half of the metanotum. Similarly, homoplasy is clearly involved in the number and placement of setae on the posterior margin and the discal area of the

sternites. Moreover, character evaluation is fraught with problems of subjectivity. For example, the posteromarginal cilia of the forewing of *Holarthrothrips* are considered to be "undulating" by some observers but here are considered to be "straight"; certainly these cilia are not undulating in this taxon in the same sense that they are in genera of the Thripidae.

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LITERATURE CITED

- Bhatti, J. S. 1986. A new species of *Holarthrothrips* (Insect: Terebrantia: Stenurothripidae) from Iraq, with notes on host plants and key to species, along with clarification of the position of this genus among Thysanoptera. *Zoology (Journal of Pure and Applied Zoology)* 1:1-33.
- Bhatti, J. S. 1990. Family groups names in the order Terebrantia (Insecta). *Zoology (Journal of Pure and Applied Zoology)* 2:185-192.
- Farris, J. S. 1988. Hennig86 Reference. Version 1.5.
- Heming, B. S. 1991. Order Thysanoptera. Chapter 28. Pp. 1-21. *In* Stehr, F.W. (ed.), *Immature Insects*, vol. 2. Kendall/Hunt, Dubuque, IA.
- Moulton, D. 1933. *Oligothrips oreios* a new genus and species of thrips belonging to the family Opadothripidae Bagnall. *Pan-Pacific Entomologist* 9:139-140.
- Mound, L. A., B. S. Heming and J. M. Palmer. 1980. Phylogenetic relationships between the families of recent Thysanoptera. *Zoological Journal of the Linnean Society of London* 69:111-141.
- Ramos, T. C. 1996. Tree Gardener 1.0. Privately distributed by [the late] Tiag Courrol Ramos, Museu de Zoologia, Universidade de São Paulo, Brasil.
- Schliephake, G. 1990. Beiträge zur Kenntnis fossiler Fransenflügler (Thysanoptera, Insecta) aus dem Bernstein des Tertiär. 1. Beitrag: Stenurothripidae. *Zoology (Journal of Pure and Applied Zoology)* 2:163-184.

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**IMMATURE STAGES OF *RHYPARONOTUS ALTARENSIS*
(OLLIFF) (COLEOPTERA: CURCULIONIDAE: MOLYTINAE),
WITH COMMENTS ON LARVAL CHARACTERS IN
ANCHONINI AND MOLYTINAE**

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Abstract.—The last instar larva and pupa of *Rhyparonotus altarensis* (Olliff) (Curculionidae: Molytinae: Anchonini), from Ecuador, are described and illustrated. Larval characters are compared with those of other Molytinae, e.g., Molytini, Hylobiini, and Phrynixini, and their phylogenetic value is discussed.

The subfamily Molytinae (recently demoted to a tribe Molytini of Curculioninae, see Kuschel, 1995) resulted from the amalgamation of about 30 tribes and subfamilies by Kuschel (1987), to which Dinomorphini (Thompson, 1992) and Bagoini (Morrone, 1997) were subsequently added (see Appendix). This cosmopolitan subfamily comprises more than 3,000 species and 300 genera (Thompson, 1992). Although several authors have treated molytines as a distinct taxon, either of tribal (May, 1993; Kuschel, 1995; Morrone & Roig-Juñent, 1995; Marvaldi, 1997) or subfamilial rank (Wibmer & O'Brien, 1986; Kuschel, 1987; Thompson, 1992; May, 1994; Zimmerman, 1994; Morrone, 1997), it is debatable whether or not this highly speciose group really represents a natural taxon. Calder (1989) has pointed out the enormous diversity of anatomical features among some of the taxa included in Kuschel's Molytinae, suggesting that this taxon was not a monophyletic group. May (1994) considered that the larvae of many genera included in Molytinae diverge so far from the typical *Hylobius* that a diagnosis of the group "would serve no useful purpose." Doubts on the monophyly of Molytinae are shared by other authors (Robin Craw, pers. comm.).

The molytine tribe Anchonini is a relatively small group (about 200 species), ranged in the Americas (from the USA to Bolivia), Japan and the Oriental region (Faust, 1892; Morimoto, 1982; O'Brien & Wibmer, 1982; Wibmer & O'Brien, 1986; Voisin, 1992, 1993). Our cursory review of the literature shows that knowledge about the biology and immature stages of this taxon is very scarce. A brief larval description of *Anchonus* Schoenherr, based on larvae of unidentified species from Bahamas and Panama, was provided by Anderson (1952), who also intended a larval definition of the tribe Anchonini. However, little confidence can be given to that tribal diagnosis as it was based on larvae of taxa not currently placed in Anchonini, except those assigned to *Anchonus*. A recently fallen *Croton* sp. tree (Euphorbiaceae) in Ecuador provided one of us (JJM) the opportunity to collect specimens of *Rhyparonotus*

altarensis (Olliff). When the bark of the tree was removed, three mature larvae, two pupae, and one adult of this species were discovered.

Our main objective is to describe the immature stages of this anchonine species. Furthermore, we discuss the phylogenetic value of some characters that could help elucidating the placement of the tribe Anchonini, as well as testing the monophyly of the subfamily Molytinae.

The specimens examined for this study have the following collection data: EC-UADOR Napo: 52 km N Tena, 6500 feet, under bark of *Croton* sp., 24-V-95, J. J. Morrone coll., det. by associated adult, 3 mature larvae, 2 pupae. The immature specimens have been deposited in the collection of the Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA), and the associated adult in the collection of the Museo de Zoología, Facultad de Ciencias (UNAM). Techniques for dissection of larvae and terminology and abbreviations here applied are those used in Marvaldi (1998). Pupae were studied following May (1987, 1994).

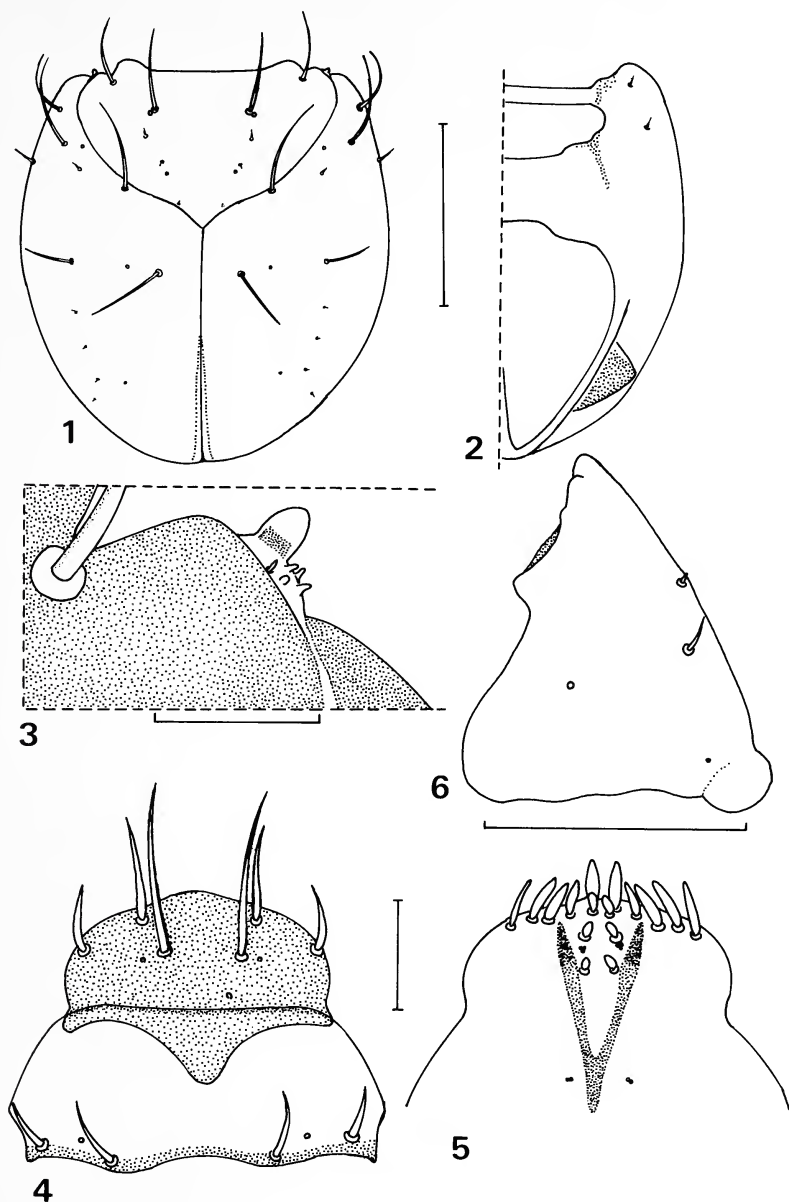
IMMATURE STAGES OF *RHYPARONOTUS ALTARENSIS* (OLLIFF)

Description. *Mature larva* (Figs. 1–14). Maximum size 13.28 mm × 3.75 mm. Head width 2.20 mm. Body robust, cuticle finely spiculate, setae rather short except for long dorsal and pleural setae on AVII–IX; AVII and AIX transverse, depressed.

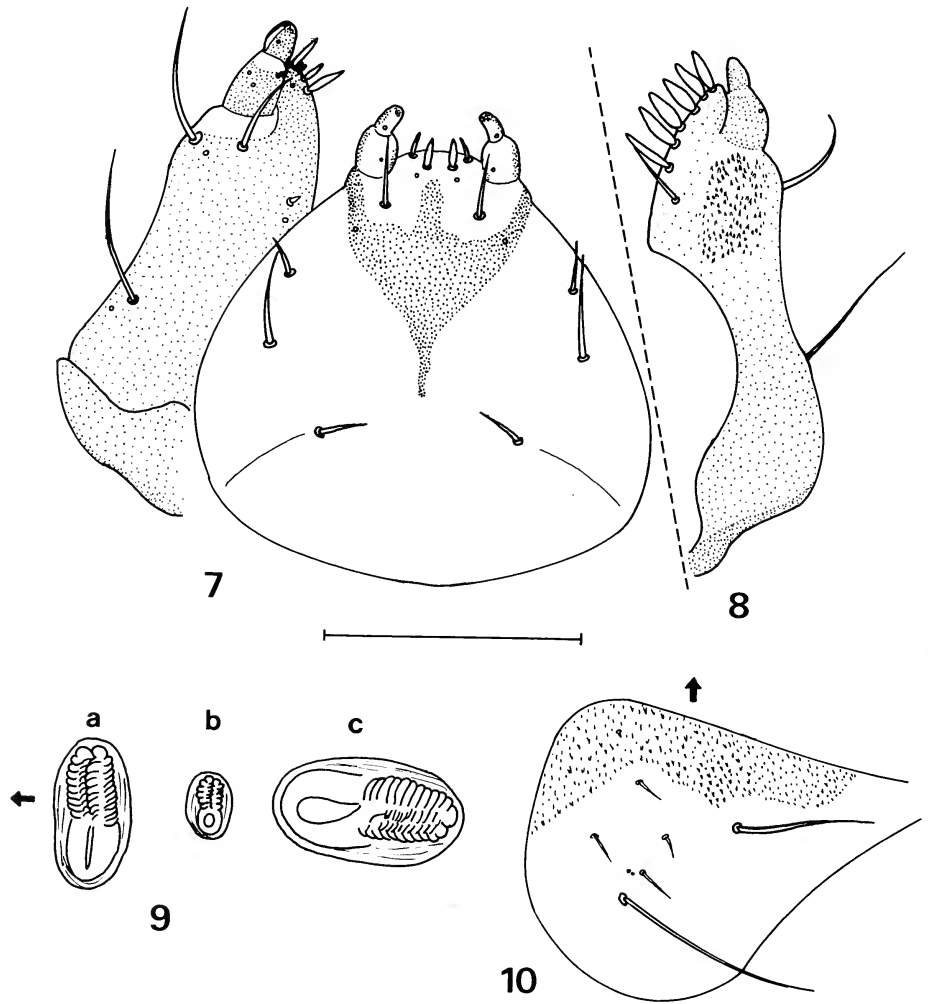
Head (Figs. 1, 2) exposed, subcircular, orange-brown pigmented. Frontal line visible in entire length, slightly angulate before apex. Endocarina absent. Postoccipital condyles well developed, obtuse-angled, pigmented. Setae: *fs*_{4,5} long, subequal, *fs*₃ very short, *fs*_{1,2} minute; *des*_{1,3,5} long, subequal, *des*₂ shorter but well developed, *des*₄ very small; *des*₃ on epicranium but close to frontal line, *pes* minute; *les*₁ short, *les*₂ long; *vcs*_{1,2} short, subequal. Only anterior stemmata distinct, as black pigmented spots. Antennae (Figs. 1, 3) small, set obliquely on anterior margin of head, partially overhung by frontal projection, antennal sensorium broadly conical. Clypeus (Fig. 4) pigmented at base, with *cls*_{1,2} well developed. Labrum (Fig. 4) transverse, completely pigmented, the anterior margin slightly projected medianly; *lms*₃ well developed but shorter than *lms*_{1,2}; lateral labral sensilla at same level than *lms*₁ and as widely separated as *lms*₂; labral rods (Fig. 5) strong, joined at base with a distinct stem, Y-shaped. Epipharynx (Fig. 5) with *ams*₁ larger as *ams*₂ and subequal to *als*; *mes*₁ as widely separated as *mes*₂; sensillum clusters locate between *mes*₁ and *mes*₂ and near base of labral rods. Mandibles (Fig. 6) bidentate at apex, with a distinct median projection on cutting edge, *mds*_{1,2} aligned longitudinally, *mds*₁ short, *mds*₂ very small, scrobe indistinct. Maxillae (Figs. 7, 8) with 5 *vms* and a row of 7 *dms*; *dms*₁ more slender than other *dms*; a patch of minute spinules present below palpus. Labium (Fig. 7) with *pms*₂ and *pms*₃ pairs separated by same distance, *pms*₁ less widely separated; premental sclerite trident-shaped, with subtriangular posterior extension.

Thorax (Fig. 11). Spiracle (Fig. 9a) large, with pigmented and finely annulated airtubes, dorsally directed. Pronotum (Fig. 11) with 9 setae plus 2 small epipleural setae. TII, III (Fig. 11) with 1 *prs*; 4 *pds* (*pds*_{1,2} short, *pds*_{3,4} long); alar area with 1 *as*; spiracular area with 2 small setae. Pedal area (Fig. 10) with 6 setae (*z* absent) plus minute *x'*; setae *t* and *w* long, others short; 2–5 sensilla present between *v* and *w*.

Abdomen (Figs. 11–14). Spiracles (Figs. 9b, c) of different size, with close-set annuli, those of AI–VII (Fig. 9b) smaller than thoracic spiracle, being the interme-

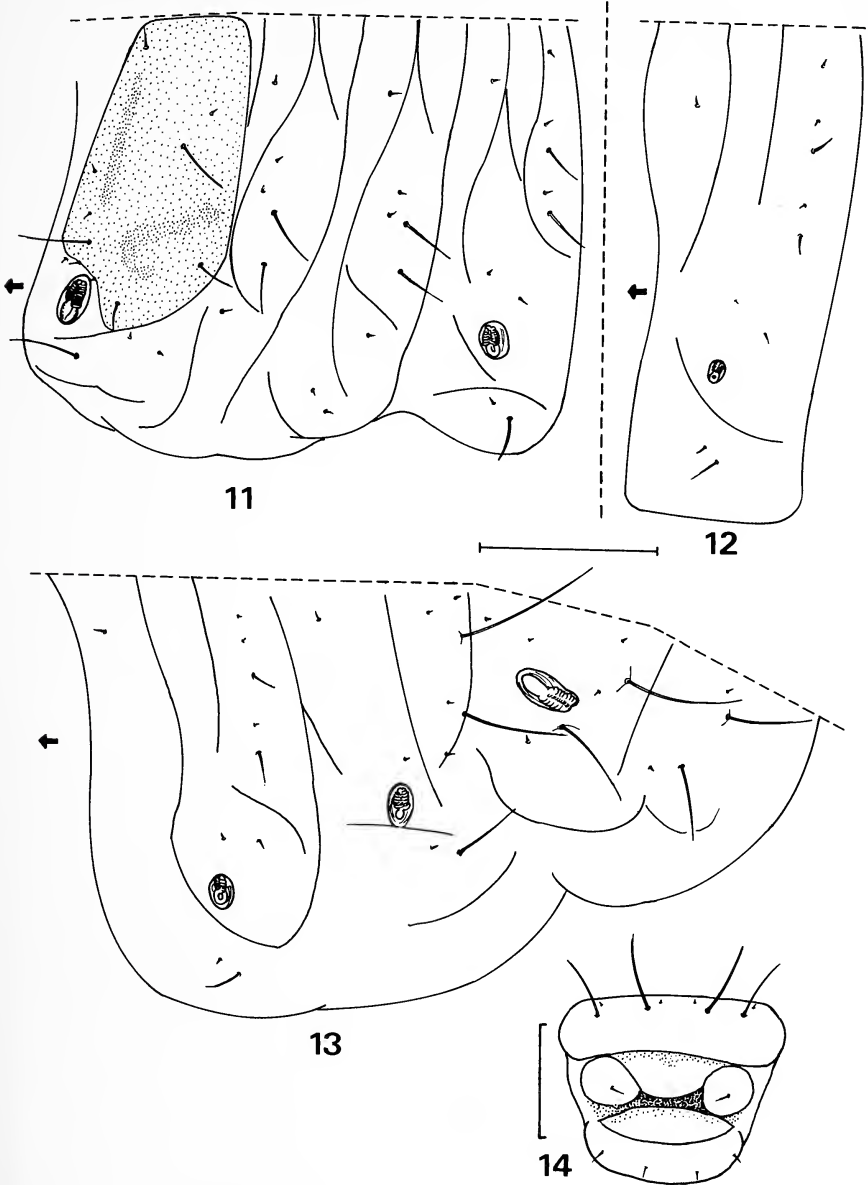


Figs. 1–6. *Rhyparonotus altarensis*, larva. 1, head, dorsal; 2, head, ventral; 3, antenna; 4, clypeus and labrum; 5, epipharynx; 6, mandible. Scales, 1,2 = 1 mm; 3 = 0.1 mm; 4–6 = 0.5 mm.

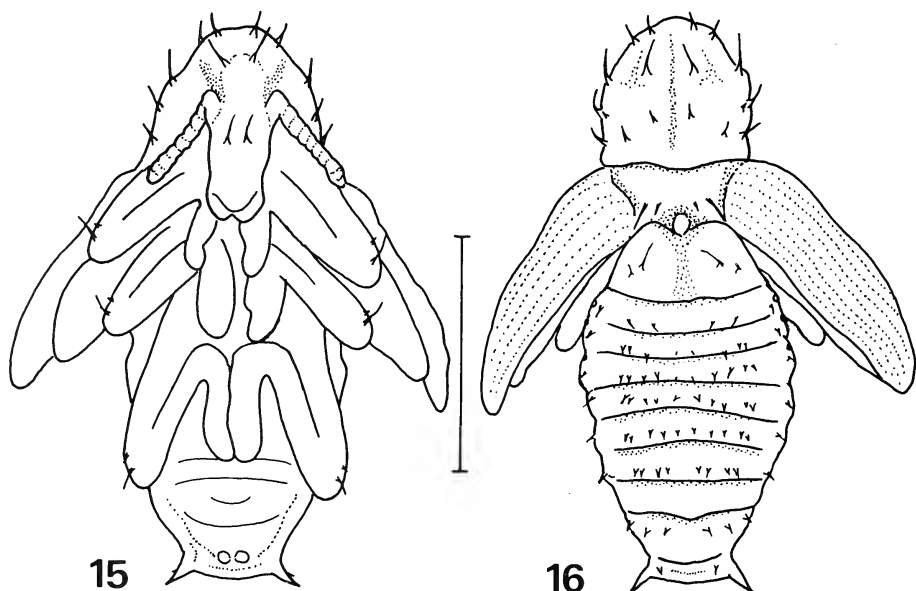


Figs. 7-10. *Rhyparonotus altarensis*, larva. 7, maxilla and labium, ventral; 8, maxilla, dorsal; 9, spiracles (a, thorax; b, AIV; c, AVIII); 10, pedal area. Scales = 0.5 mm.

diate ones smallest, airtubes dorsally directed; AVIII spiracle (Fig. 9c) placed on dorsum and larger than other 7 and than thoracic one, with airtubes posteriorly directed. AI-VII (Figs. 11-13) with *prs* small, vestigial on AVIII; AI-VII with 5 *pds*: *pds*3.5 longer than others, distinctly longer and stronger on AVII; AI-VI with *ss*1.2 on spiracular area; AVII with *ss*2 shifted to postdorsum and *pds*2 set ahead of other *pds*. AVIII (Fig. 13) with 3 *pds* which appear to correspond with *pds*4 (minute), *pds*5 (large and strong) and *ss*2 (minute) of preceding segments. AIX (Figs. 13, 14) with 2 unequal *ds*. AX (Fig. 14) ventral, 4-lobed, anus transversal, lateral lobes smallest bearing 1 small seta.



Figs. 11-14. *Rhyparonotus altarensis*, larva. 11-13, one side, dorsolateral; 11, TI-III, AI; 12, AIV; 13, AVI-X. 14, AIX, X, caudal view. Scales = 1 mm.



Figs. 15, 16. *Rhyparonotus altarensis*, pupa, habitus. 15, ventral; 16, dorsal. Scale = 5 mm.

Pupa (Figs. 15, 16). Maximum length 11.95 mm. Setae as in Figs. 15, 16. Cuticle glabrous. Setae orange-brown, tapering, moderately strong on head and pronotum, smaller on abdomen, mounted on small tubercles. Antennal club smooth. Each femur with a pair of unequal setae. Secondary pterotheca shorter than primary. Spiracles distinct, with dark peritreme. AIX with prominent posterior processes, each with a small associated seta located laterally at base.

DISCUSSION

The larva of *Rhyparonotus altarensis* presents some characters that are similar to those of *Anchonus* spp. indet. studied by Anderson (1952), such as: endocarina absent, antennae overhung by frontal projection, labrum completely pigmented with anterior margin produced medianly, maxillary mala with 7 *dms*, AI-VII (typical abdominal segments) with 3 dorsal folds, spiracle on AVIII dorsal and larger than those of anterior segments, and body asperities fine. These features may be useful to diagnose the tribe in the larval stage, but they are also present among other molytine larvae. The anchonine larvae herein studied and those examined by Anderson (1952) are different, however, in characters involving the position of *des*3, shape of labrum and position of lateral sensilla, shape of labral rods, arrangement of *als* on epipharynx, structure of mandible on cutting edge (inner margin), orientation of spiracular airtubes on AI-VII, relative length of *pds*5 on AI-VII, and number of *pds* on AVIII and AIX. These characters may be diagnostic at generic level within Anchonini.

According to May (1993), Molytinae comprise two distinct elements: "live tissue feeders" (=tribes Molytini and Hylobiini), with modal mouthparts, and "inhabitants

of dead wood" (=tribe Phrynixini), with mouthparts adapted to xylophagy. The larvae of *Rhyparonotus* herein studied, apparently subcortical borders in dying trunks, fall in the former group, characterized by the pigmented head, transverse labrum, clear hypopharyngeal bracon, broadly conical antennae, and maxilla with 2 setae on palpifer and 7 *dms*, plus TII, III with long *pds4*. These characters, however, appear to be plesiomorphic when compared with other weevil larvae, and thus, provide no evidence for monophyly. The latter group may correspond instead with a monophyletic group, because although several mouthpart characters defining it are hypothesized as "adaptations for xylophagy" (May, 1993), their maxillae with 3 setae on palpifer and 10 *dms*, and the short *pds4* on TII, III may be apomorphies of *Phrynixus* and its allies.

May (1993) considers "labral rods separate, subparallel or bowed" to diagnose Molytinae (from the Australian Region). However, larvae of *Rhyparonotus* herein studied, as well as those of *Heilipodus erythropus* (Rosado-Neto, 1980), belonging to the tribe Hylobiini, show Y-shaped labral rods (joined at base with a distinct stem), which could be phylogenetically informative. It is worth noting that, among other Curculionidae, labral rods Y-shaped define the larvae of Cryptorhynchinae, which can be distinguished from those of Molytinae by their lateral AVIII spiracles (May, 1993, 1994). We have noted that the 3 *pds* on AVIII of *Rhyparonotus* larvae (and probably other molytines, as suggested by figures in literature) appear to correspond with *pds4*, *pds5* and *ss2* of preceding segments. This is different in larvae of Rhytirrhini and some Aterpini (Cyclominae), that lack *pds5* and *ss2* on AVIII (Marvaldi, 1998). Although there are examples of molytine larvae with *des3* on frontal line or on frons (e.g., Anderson, 1952:291; May, 1993:82), those of typical Molytinae (e.g., *Hylobius*) have *des3* on epicranium. The latter character allows separation from the morphologically similar larvae of Aterpini with *des3* always on frons or on frontal line (May, 1994). To this could be added that most (though not all) larvae of Molytinae have only 2 *ds* on AIX. All these characters also provide separation from larvae of Rhytirrhini, which in addition are diagnosed by their very reduced lateral labral setae. Larvae of Molytinae, with distinct postoccipital condyles and AVIII spiracles on dorsum, can be separated quite easily from those of Cossoninae and Scolytinae (Marvaldi, 1997), but they are difficult to distinguish, morphologically, from some Curculioninae *s. str.* (May, 1993, 1994).

Further studies on immature stages, including some less "typical" Molytinae, e.g., Petalochilini or Juanorhinini, are still needed in order to test the monophyly of Molytinae. Similarly, a more complete sample of larvae representative of Anchonini would be valuable to define this tribe at the larval stage and to ascertain the phylogenetic relationships of the Anchonini.

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LITERATURE CITED

- Anderson, D. M. 1991. Curculionidae (broad-sense) (Curculionoidea). Pp. 594–612. In: Stehr, F. W. (ed.), Immature Insects, Vol. 2. Kendall/Hunt Publishing Company.

- Anderson, W. H. 1947. A terminology for the anatomical characters useful in the taxonomy of weevil larvae. *Proc. Ent. Soc. Washington* 49:123-132.
- Anderson, W. H. 1952. Larvae of some genera of Cossoninae (Coleoptera: Curculionidae). *Ann. Entomol. Soc. Amer.* 45(2):281-309.
- Böving, A. G. and F. C. Craighead. 1930. An illustrated synopsis of the principal larval forms of the order Coleoptera. *Entomol. Amer.* 11(1-4):1-351.
- Calder, 1989. The alimentary canal and nervous system of Curculionoidea (Coleoptera): Gross morphology and systematic significance. *J. Nat. Hist.* 23:205-265.
- Faust, J. 1892. Die Anthoniden-Gruppe. *Dtsch. Ent. Zeitschr.* 1892:17-60.
- Gardner, J. C. M. 1933. The early stages of two Indian weevils. *Stylops* 2:81-85.
- Gardner, J. C. M. 1934. Immature stages of Indian Coleoptera (14) (Curculionidae). *Indian Forest Records* 20(2):1-42.
- Gardner, J. C. M. 1938. Immature stages of Indian Coleoptera (24 Curculionidae Contd.). *Indian Forest Records, Entomol. Ser.* 3(12):227-261.
- Kuschel, G. 1987. The subfamily Molytinae (Coleoptera: Curculionidae): General notes and descriptions of new taxa from New Zealand and Chile. *New Zealand Entomol.* 9:11-29.
- Kuschel, G. 1995. A phylogenetic classification of Curculionoidea to families and subfamilies. *Memoir Entomol. Soc. Wash.* 14:5-33.
- Lee, C. and K. Morimoto. 1988. Larvae of the Weevil Family Curculionidae of Japan. Part 2. Hyperinae to Cioninae (Insecta: Coleoptera). *J. Fac. Agr., Kyushu Univ.* 33(1-2):131-152.
- Marshall, G. A. K. 1932. Notes on the Hylobiinae (Col., Curc.). *Ann. Mag. Nat. Hist. ser. 10,* 9:341-355.
- Marvaldi, A. E. 1997. Higher level phylogeny of Curculionidae (Coleoptera: Curculionoidea) based mainly on larval characters, with special reference to broad-nosed weevils. *Cladistics* 13:285-312.
- Marvaldi, A. E. 1998. Larvae of South American Rhytirrhinae (Coleoptera: Curculionidae). *Coleopt. Bull.* 52(1):71-89.
- May, B. M. 1971. Entomology of the Aucklands and other islands south of New Zealand: Immature stages of Curculionoidea. *Pacific Insects Monograph* 27:271-316.
- May, B. M. 1973. A new species of *Megacolabus* and descriptions of the immature stages of *M. decipiens* (Coleoptera: Curculionidae). *Journal of the Royal Society of N. Z.* 3:255-262.
- May, B. M. 1979. Immature stages of Curculionidae: the "rat-tailed" larva and the pupa of *Notonesius aucklandicus* (Phrynixinae). *N. Z. Journal of Zoology* 6:577-582.
- May, B. M. 1981. Immature stages of Curculionoidea—the weevils of The Snares Islands, New Zealand. *N. Z. Journal of Zoology* 8:255-280.
- May, B. M. 1987. Immature stages of Curculionidae (Coleoptera): the larva and pupa of *Karocolens pittospori* (Molytinae). *N. Z. Entomologist* 9:29-34.
- May, B. M. 1993. Larvae of Curculionoidea (Insecta: Coleoptera): A systematic overview. *Fauna of New Zealand* 28:1-223.
- May, B. M. 1994. An introduction to the immature stages of Australian Curculionoidea. Pp. 365-755. *In: Zimmerman, E. C., Australian Weevils, Vol. II. Melbourne, CSIRO.*
- Morimoto, K. 1982. The family Curculionidae of Japan. I. Subfamily Hylobiinae. *Esakia* 19: 51-121.
- Morrone, J. J. 1997. Argentinian weevils (Coleoptera: Curculionoidea): Preliminary overview, with nomenclatural and distributional notes. *Physis (Buenos Aires)* (in press).
- Morrone, J. J. and S. A. Roig-Juñent. 1995. The diversity of Patagonian weevils: An illustrated checklist of the Patagonian Curculionoidea (Insecta: Coleoptera). *L. O. L.A., Buenos Aires*, 189 pp.

- Oberprieler, R. G. 1988. The life history of *Paramecops stapeliae* (Marshall), with a review of the genus *Paramecops* (Coleoptera: Curculionidae: Molytinae). J. Nat. Hist. 22:1451–1464.
- O'Brien, C. W. and G. J. Wibmer. 1982. Annotated checklist of the weevils (Curculionidae *sensu lato*) of North America, Central America, and the West Indies (Coleoptera: Curculionoidea). Mem. Amer. Ent. Inst. 34:382 pp.
- Peterson, 1951. Larvae of insects. Part II Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera. 1st ed., Edward Bros., Inc., Ann Arbor, 134 pp.
- Rosado-Neto, G. H. 1980. Description of larva and pupa of *Heilipodus erythropus* (Klug, 1829) (Coleoptera, Curculionidae). Rev. bras. Ent. 24(2):111–115.
- Scherf, H. 1964. Die entwicklungsstadien der mitteleuropäischen Curculioniden (Morphologie, Bionomie, Ökologie). Abh. Senckenberg. Naturf. Ges. 506:1–355.
- Thompson, R. T. 1992. Observations on the morphology and classification of weevils (Coleoptera, Curculionoidea) with a key to major groups. J. Nat. Hist. 26:835–891.
- Voisin, J.-F. 1992. *Gibbanchonus* n. gen. et *G. krausei* n. sp. du Mato Grosso (Brésil) (Insecta, Coleoptera, Curculionidae: Molytinae). Reichenbachia Mus. Tierk. Dresden 29(18):93–95.
- Voisin, J.-F. 1993. Notes sur la tribu des Anchonini: 2. Description de quatre genres nouveaux et revue de six anciens (Coleoptera, Curculionidae). Nouv. Rev. Ent. (N.S.) 10(4):327–340.
- Wibmer, G. J. and C. W. O'Brien. 1986. Annotated checklist of the weevils (Curculionidae *sensu lato*) of South America (Coleoptera: Curculionoidea). Mem. Am. Entomol. Inst. (39):i–xvi, 1–563.
- Zimmerman, E. C. 1994. Australian Weevils, Vol. I. Melbourne, CSIRO, 741 pp.

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Appendix. Tribes assigned to Molytinae (after Kuschel, 1987; Thompson, 1992; Morrone, 1997). Genera between brackets are those for which larvae have been described.

Acicnemidini Lacordaire

Amalactini Lacordaire

Anchonini Imhoff (*Anchonus* [Anderson, 1952]).

Bagoini Thomson (*Bagous* [Scherf, 1964; May, 1994]).

Cholini Schoenherr

Cycloterini Marshall

Dinomorphini Lacordaire

Emphyastini Lacordaire

Euderini Lacordaire

Galloisiini Morimoto

Guioperini Lacordaire

Haplonychini Lacordaire

Hylobiini Kirby (=Heilipinae Faust) (*Acles* [Gardner, 1938]; *Heilipodus* [Rosado-Neto, 1980]; *Heilipus* [Böving & Craighead, 1930]; *Hylobius* [Gardner, 1938; Scherf, 1964; Anderson, 1991]; *Kobuzo* [Gardner, 1938]; *Pagiophloeus* [Gardner, 1934]; *Paramecops* [Gardner, 1934; Oberprieler, 1988]).

Ithyporini Lacordaire (=Conotrachelini) (*Conotrachelus* [Peterson, 1951; Anderson, 1991]).

Juanorhinini Aurivillius

Lepyrini Faust

Lithinini Lacordaire

- Lymanini Lacordaire (genus indet. near *Ithaura* [Anderson, 1952]).
- Mecysolobini Reitter (*Mesalcidodes* [Lee & Morimoto, 1988]).
- Molytini Schoenherr (=Liparini Latreille) (*Arecophaga* [May, 1993]; *Hadramphus* [May, 1971, 1981]; *Karocolens* [May, 1987]; *Liparus* [Scherf, 1964]; *Lyperobius* [May, 1981]; *Paedaretus* [May, 1993]).
- Nettarhinini Lacordaire
- Omophorini Marshall
- Pacholenini Lacordaire
- Paipalesomini Marshall (*Paipalesomus*, *Peribleptus* [Gardner, 1993]).
- Petalochilini Lacordaire
- Phoenicobatini Champion
- Phrynixini Kuschel (*Megacolabus* [May, 1973]; *Notonesius* [May, 1979]; *Phrynixus* [May, 1971, 1981]; *Rhysheus* [May, 1993]).
- Pissodini Thomson (*Pissodes* [Anderson, 1947; Scherf, 1964]).
- Sternechini Lacordaire (*Chalcodermus* [Peterson, 1951; Anderson, 1991]).
- Styanacini Chujo & Voss
- Trypetidini Lacordaire (*Heteramphus*, *Nesotocus* [Anderson, 1952]).
- Molytinae *insertae sedis* (*Demysus*, *Melanotrane*, *Orthorhinus*, *Tranes* [May, 1994]).

**ANOSIOSTES PAULIANI NEW SPECIES AND FIRST RECORD
OF THE GENUS FROM MEXICO (COLEOPTERA:
SCARABAEIDAE: CERATOCANTHINAE)**

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Abstract.—A new Mexican species of *Anopsiostes* Paulian is described and illustrated; this monotypical genus was previously known only from Ecuador. The distinctive characters of both species and the Antillean genus *Nesopalla* Paulian and Howden are commented.

American ceratocanthines are represented by 140 species and 15 genera, there are 111 species and 14 genera in South America, and only three species and two genera in North America (Howden and Gill, 1988a, 1988b; Paulian, 1982). Mexican and Central American taxa have not yet been revised and currently there are 26 species and four genera recorded for these countries (Bates, 1887; Blackwelder, 1944; Paulian, 1982).

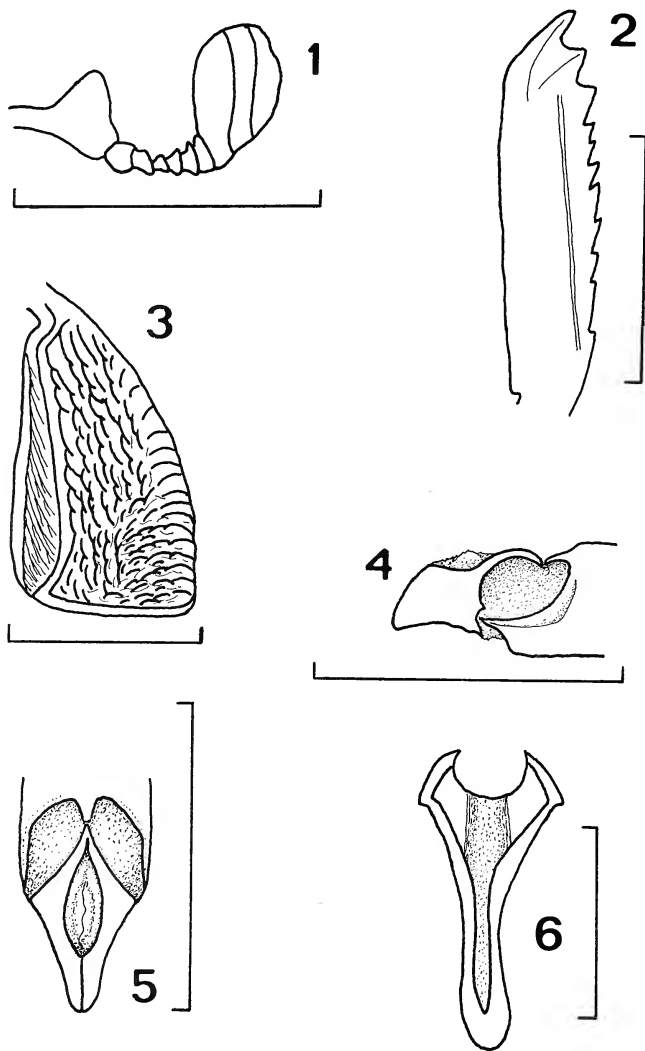
The genera *Nesopalla* Paulian and Howden and *Anopsiostes* Paulian are characterized by the eyes not seen from above, only in lateral view; the first genus is represented by two Antillean species and the second one is monotypical, restricted to Ecuador (Paulian, 1982; Paulian and Howden, 1982). In this paper we describe a second species of *Anopsiostes* recently collected at the tropical moist forest of the Mexican state of Veracruz.

***Anopsiostes pauliani*, new species**

Figs. 1-6

Description. *Holotype male.* Length (unrolled body) 5.5 mm; maximum width (at basal third of elytra) 1.6 mm. Dorsal color metallic green with opaline lustre; surface with simple punctures and very minute setae (scarcely visible at 50×). Clypeus triangular with apex pointed, surface with dense, medium punctures, except on the apical and lateral regions; genae continuous with sides of clypeus; frons convex with punctures smaller than those of clypeus. Eyes not visible from above. Antennae with 10 articles (Fig. 1). Mentum without transverse suture; labial palpi with last article longer than preceding one. Labrum with apex slightly concave and ventrally extended at middle.

Pronotum transverse, margins entirely beaded; pronotal anterior angles obtuse but rounded, lateral borders with anterior half bent downwards; pronotal surface evenly convex with dense, small punctures gradually becoming larger and denser to anterior angles; a small, smooth areas present on the basal, apical and lateral regions. Scutellum with scarce, fine punctures. Elytra strongly convex, bent downwards at apex, with a feeble humeral umbone; elytral surface with irregular rows of small, shallow, rounded or oval punctures, rows not reaching the base except by a few punctures of the sutural stria; marginal stria broad, furrowed, continuous with the sutural stria at



Figs. 1-6. *Anopsiostes pauliani*, sp. nov. 1. Antenna, ventral view. 2. Fore tibia, dorsal view. 3. Hind tibia, ventral view. 4. Parameres, lateral view. 5. Parameres, dorsal view. 6. Spiculum gastrale, frontal view, Scale = 1 mm.

apex; sutural stria deeply impressed at apical declivity; three striae adjacent to marginal one with elongate, partially fused punctures; intervals flattened, sparsely and finely punctated; outermost interval convex at basal third. Hind wings well developed.

Fore tibia with three apical teeth on external border (Fig. 2). Middle and hind tibiae flattened, triangular, with apex truncate and thin; outer spur of middle tibia very short; ventral face of hind tibia divided by a longitudinal ridge, internal face

with longitudinal striae adjacent to ridge, external face with longitudinal, arcuate streaks and transverse, short lines near the external and apical borders (Fig. 3). Hind tarsi articulate on dorsal face of tibia and slightly longer than tibial apex. Genitalia with parameres short, symmetrical (Figs. 4–5); spiculum gastrale with a long manubrium (Fig. 6).

Variation. Length of female paratype is 5.4 mm and maximum width is 1.6 mm; similar to holotype except; dorsal color darker, pronotal punctation slightly sparser, scutellum with larger punctures and outer spur of middle tibia longer.

Etymology. This species is respectfully dedicated to Dr. Renaud Paulian in recognition of his great contribution to knowledge of the Coleoptera Scarabaeoidea, author of the revisions of Ceratocanthinae from Africa and South America.

Types. Holotype, ♂, MEXICO, Veracruz, Córdoba, Cuauhtémoc, alt. 940 m, 16-18-vi-1996, selva, trampa de luz, R. Hernández y L. Delgado (Instituto de Ecología, A.C., Xalapa, Mexico). Paratype: MEXICO, Veracruz: 1 ♀, same data as holotype (Collection of L. Delgado, Mexico City).

Discussion. This species can be distinguished from *Anopsiostes punctatus* Paulian, only other known species of the genus, by the dorsal color metallic green, not shining black; the pronotal anterior margin completely beaded, not beaded only at sides; the elytral disc with sparse punctation, not densely punctated; the fore tibia with three apical teeth, not with two teeth; and the hind tarsi slightly longer than apex of tibia, not shorter than this.

The Antillean genus *Nesopalla* is the another American genus with the eyes not seen from above, however this genus can be separated from *Anopsiostes* by the dorsal pubescence distinctly visible, the dorsal punctation ocellate or densely shagreened, the genae rounded and prominent, the vertex with a tubercle, and the mentum with a transverse suture. At present, the two genera seem very isolated from the remaining American genera of Ceratocanthinae and both show possible relationships with some genera of the Old World (Paulian, 1982; Paulian and Howden, 1982).

Distribution. *Anopsiostes pauliani* is only known from one locality at the external slope of the mountainous system Sierra Madre Oriental, this locality presents a little disturbed tropical evergreen seasonal forest located at 940 m of altitude; these physical characteristics are partially similar to those where occurs the Ecuadorean *A. punctatus*, however in this region of Ecuador is presents a tropical rain forest with higher canopy, located at 250 m of altitude and with higher rainfall and moisture.

The discovery of *A. pauliani* suggests than other species of this genus may be found in the tropical moist forests present between Ecuador and Mexico.

LITERATURE CITED

- Bates, H. W. 1887. *Biologia Centrali-Americana. Insecta, Coleoptera*. Vol. 2, Pt. 2:25–160.
Blackwelder, R. E. 1944. Checklist of the coleopterous insects of Mexico, Central America, the West Indies and South America. Pt. 2. Bull. USNM 185:189–341.
Howden, H. F. and B. D. Gill. 1988a. *Xenocanthus*, a new genus of inquiline Scarabaeidae from southeastern Venezuela (Coleoptera). Can. J. Zool. 66:2071–2076.
Howden, H. F. and B. D. Gill. 1988b. A fourth genus of unusually modified Ceratocanthinae (Coleoptera: Scarabaeidae) from South America. Can. J. Zool. 66:2077–2079.

- Paulian, R. 1982. Révision des Cératocanthides (Coleoptera, Scarabaeoidea) d'Amerique du Sud. Mem. Mus. Nat. Hist. (N.S.), Ser. A, Zool. 124:1-110.
- Paulian, R. and H. F. Howden. 1982. Un nouveau genre de Ceratocanthides des Antilles (Col. Scarabaeoidea). Bull. Soc. ent. France. 87:78-85.

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THE LARVA OF *HYPENA MANALIS* (LEPIDOPTERA: NOCTUIDAE: HYPENINAE)

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Abstract.—The larval food plant of *Hypena manalis* (Walker) proves to be bog hemp, *Boehmeria cylindrica* (L.). Partly grown larvae rejected stinging nettle, *Urtica dioica* (L.). The mature larva of *H. manalis* is described and illustrated. It is compared to larvae of *H. bijugalis*, *H. baltimoralis*, *H. madefactalis*, and *H. humuli*.

Late at night in early July, while netting moths with the aid of a headlamp, a *Hypena manalis* (Walker) female was flushed from a clump of vegetation in a *Phalaris* swamp near Albany, New York. On closer inspection the clump was determined to contain *Boehmeria cylindrica* (L.), *Asclepias incarnata* L., *Typha angustifolia* L., *Equisetum fluviatile* L., and *Phalaris drundinacea* L. The moth was caged with a leaf of each plant. *Hypena* species are known to be monophagous or oligophagous. The captive moth oviposited readily on everything, but only the *Boehmeria cylindrica* [Urticaeae] was fed upon by the first instar. Partly grown larvae were offered but refused the related *Urtica dioica* L.

We are treating *Bomolocha* Hübner (1816) and *Hypena* Schrank (1802) as synonymous and *Hypena* has priority. The use of either *Bomolocha* or *Hypena* for this assemblage of species has had a checkered history. Both Beck (1960) and Crumb (1934) used the condition of the Abd-3 prolegs to separate *Bomolocha* (proleg present) from *Hypena* (absent). The state of development of the Abd-3 proleg proves variable. Caterpillars of both *H. humuli* (Harris) and *H. manalis* have completely rudimentary Abd-3 prolegs, a feature not shared by the other *Hypena* examined. Among the remaining species examined, *H. madefactalis* has well developed Abd-3 prolegs; *Hypena baltimoralis* and *H. bijugalis* have reduced, but functional Abd-3 prolegs. Forbes (1954) remarked on the intergradation of temperate *Bomolocha* with tropical *Hypena*. In his catalog, Poole (1989) listed *Bomolocha* under *Hypena* bringing the total number of generic synonyms of *Hypena* to eighteen. Lödl (1994) subsequently considered *Dichromia* a valid genus and restored it from synonymy. Lödl added *Trichypena* Joannis to the synonymy and created six new subgenera of *Hypena*.

Hypena humuli feeds on hop, *Humulus lupulus* L., and stinging nettle, *Urtica dioica* [both Urticaceae]. Other known hosts for Nearctic *Hypena* species include: maple (*H. baltimoralis* Guenee), dogwood (*H. bijugalis* Walker), elm (*H. abalienalis* Walker), walnut (*H. madefactalis* Guenee), butternut (*H. sordidula* and *H. madefactalis*), alder (*H. sordidula* Grote), oak and hazel (*H. palparia* Walker), and basswood (*H. deceptalis* Walker). In addition, there are other nettle feeders (*H. californica* Behr, *H. decorata* Smith, *H. modestoides* Poole). Elm is related to nettle suggesting a close relationship of *H. abalienalis* to *H. manalis*. Unfortunately, no *H. abalienalis*

larva was available for comparison. Dyar (1891) described the larva of *H. abalienalis*; he reported a normal complement of prolegs.

Hypena manalis occurs from southern Canada to Florida west to Minnesota, Iowa and Arkansas (Forbes, 1954). The host plant, bog hemp, has a similar distribution, but extends further south to Texas (Fernald, 1950).

MATURE LARVAE OF *HYPENA MANALIS*
(Chaetotaxy follows Hinton, 1946)

Description. *Coloration of living material.* Head light brown with darker brown reticulation extending to stemmata; body grass-green with three obscure darker green dorsal stripes on each side; with yellow intersegmental sutures.

General: Average head width 1.75 mm; average total length (fully extended) 23 mm; abdominal prolegs absent on Abd 3, present on Abd 4th, 5th, 6th, & 10th segments; setae simple; crochets a uniordinal mesoseries, averaging 25 (24–28) on each proleg (N = 8).

Head (Fig. 1): Epicranial suture 0.5 mm long; height of frons 0.5 mm.

Mouthparts: Hypopharyngeal complex (Fig. 3): spinneret longer than labial palpus, apex lacking setae; stipular seta (S) between prementum and base of labial palpus; distal region of hypopharynx with a patch of fine setae, proximal region bears a single row of ten rather thick spines.

Mandible (Fig. 2): A prominent mesal tooth on oral face.

Thoracic segments: Prothorax (Fig. 5): Cervical shield weakly sclerotized. All setal bases lack pinaculi.

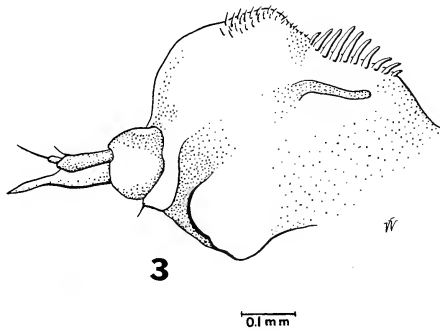
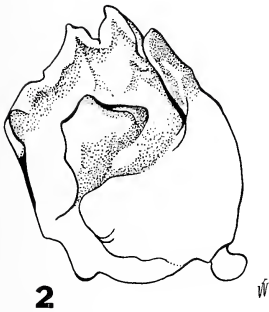
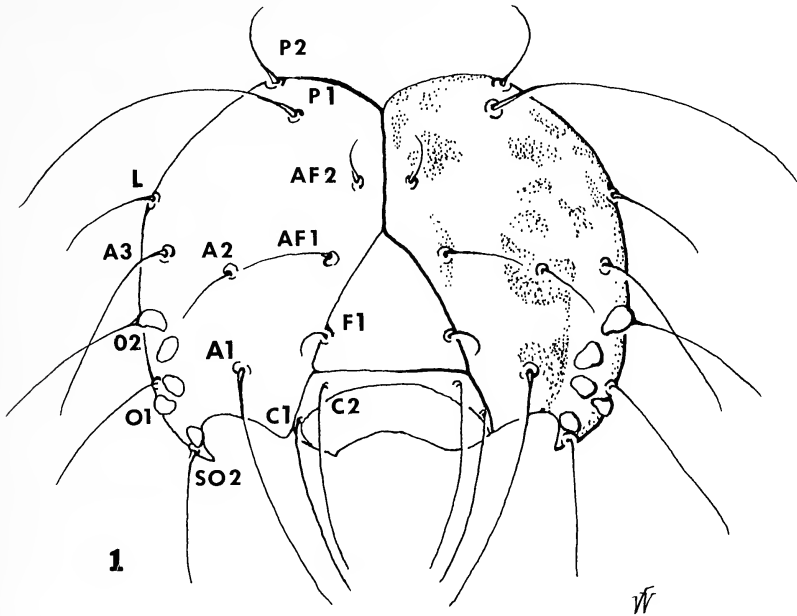
Abdominal segments (Fig. 4): A pinaculum at the base of SD-1 on all abdominal segments.

Material examined. Eight specimens, reared ex ovo from female collected by one of the authors (TLM) at Black Creek Swamp, lat. 42.39.53 long. 73.58.01, on 2 July 1994. Reared adults, photographs, and preserved larvae coded tlm 94-44. Mature larvae preserved 1 August 1994.

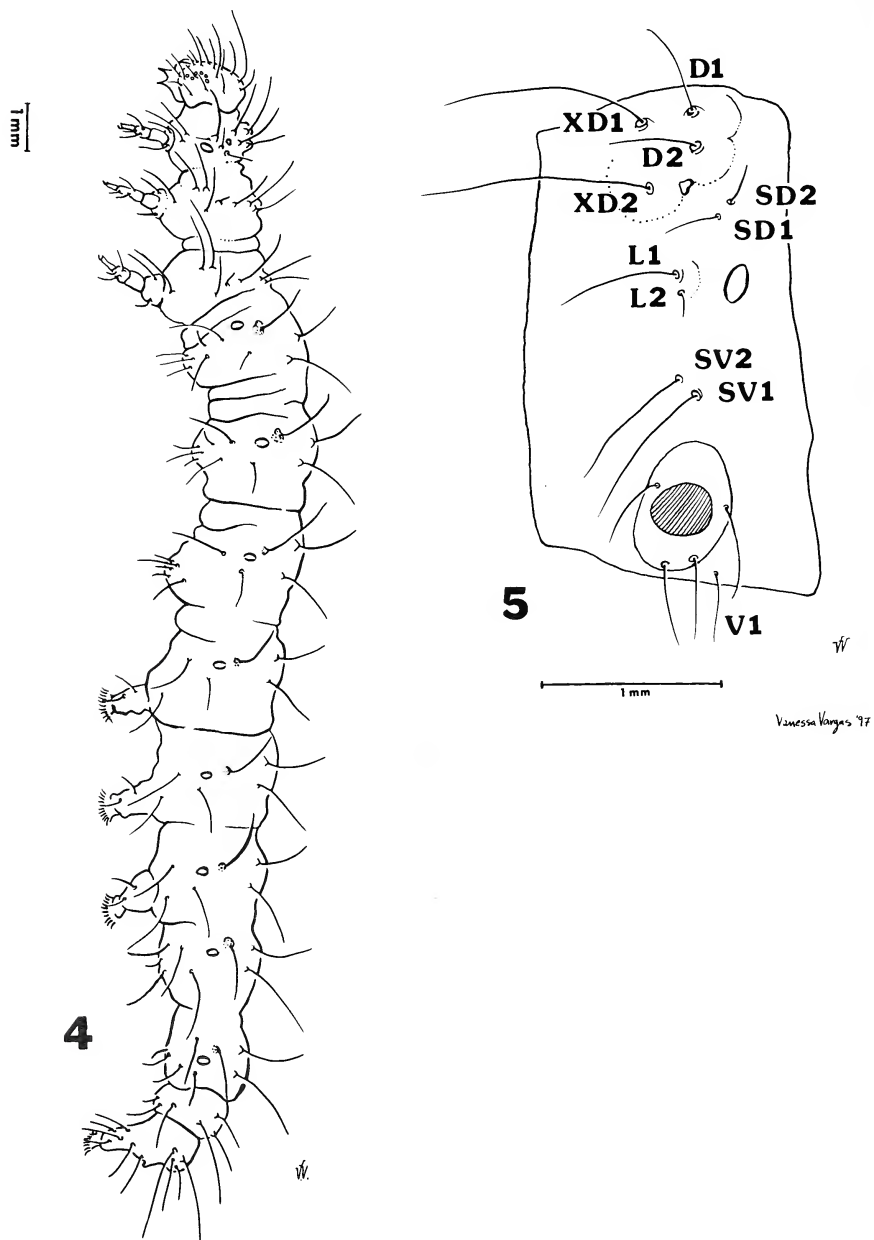
DIAGNOSIS

We compared *H. manalis* larvae to those of *H. baltimoralis*, *H. bijugalis*, *H. madefactalis*, and *H. humuli*. *Hypena manalis* and *H. humuli* were the only other ones with Abd-3 prolegs absent. *Hypena bijugalis* does have slightly reduced, but fully functional Abd-3 prolegs. *Hypena humuli* had prominent black setal bases, particularly on the head, and only the top of the head capsule was freckled. *Hypena manalis* had pale setal bases and the head was extensively reticulated, even including the stemmatal region (see Fig. 1).

All five *Hypena* larvae examined had a mesal tooth on the oral face of the mandible. This mandibular structure was most similar between *H. manalis* and *H. humuli*. Their tooth appears as a flat-topped, even-sloped prominence (see Fig. 2). The mesal tooth of *H. bijugalis* is rounded, *H. madefactalis* is flat-topped but parallel-sided, and *H. baltimoralis* has a very shallow tooth. *Hypena baltimoralis* and *H. madefactalis* were the only *Hypena* larvae examined that possessed posterior coronal punctures. The head of *H. baltimoralis* had dark pigment at the base of the D1, D2, L1 and A2 setae. *Hypena madefactalis* had two prominent, black, pigmented patches at



Figs. 1–3. Last instar of *Hypena manalis*. 1. Head capsule, frontal view (scale line = 1.0 mm). 2. Oral face of left mandible (scale line = 0.1 mm). 3. Hypopharyngeal complex, lateral view (scale line = 0.1 mm).



Figs. 4-5. Last instar of *Hypena manalis*. 4. Lateral view of larva (scale line = 1.0 mm). 5. Prothorax, semidiagrammatic view of left side from middorsal line to midventral line (scale line = 1.0 mm).

the base of L and P1 on the head in one color morph; the other morph lacked obvious patches.

COLORATION OF LIVING MATERIAL

All five species examined in life had yellowish intersegmental sutures. *H. made-factalis* was unusual in that the larvae were dichromatic: one form had black, heavily pigmented, dorsal pinaculi and two pairs of prominent black spots on the head capsule; the other form lacked the black spots on the head and the body setal bases were reddish and nondescript. Both forms had a prominent white, subdorsal stripe. *Hypena manalis* and *H. bijugalis* had three vague stripes on the dorsal half, lacking in *H. baltimoralis*. *H. manalis* had the most profusely freckled head capsule. *Hypena humuli* possessed a white spiracular stripe that was distinct only on Abd 8–10.

In adult habitus, *H. manalis* is most similar to *H. bijugalis* (see Holland, 1903, The Moth Book, Plate XLII, figs. 3 & 7).

ACKNOWLEDGMENTS

Preserved larvae and reared adults are vouchered in the New York State Museum. Vanessa Vargas produced the illustrations. This is published as Contribution number 785 of the New York State Science Service.

LITERATURE CITED

- Beck, H. 1960. Die Larvalsystematik der Eulen (Noctuidae). Abh. Larvalsyst. Insekten 4:406 pp.
- Crumb, S. E. 1934. A classification of some noctuid larvae of the subfamily Hypeninae. Entomologica Americana 14:133–197.
- Dyar, H. G. 1891. Descriptions of three noctuid larvae. Can. Entomol. 23:156–158.
- Fernald, M. L. 1950. Gray's Manual of Botany. D. Van Norstrand Co. 1632 pp.
- Forbes, W. T. M. 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem. 329. 433 pp.
- Hinton, H. E. 1946. On the homology and nomenclature of the setae of lepidopterous larvae. Trans. Roy. Entomol. Soc. London 97:1–37.
- Holland, W. J. 1903. The Moth Book. Doubleday, Page & Co., New York. 479 pp.
- Hübner, J. 1816. Verzeichniss bekannter Schmetterlinge. Augsburg. 431 pp.
- Lödl, M. 1994. Revision der Gattung *Hypena* Schrank, 1802 s.l., der Äthiopischen und Madagassischen Region, Teil 1. Annalen des Naturhistorischen Museums in Wien. 96B:373–590.
- Poole, R. W. 1989. Lepidopterorum Catalogus. Fascicle 118. Noctuidae (3parts). E. J. Brill/Flora & Fauna Publications, New York. 1314 pp.
- Schrank, F. P. 1802. Fauna Boica. Durchgedachte Geschichte der in Baiern Einheimischen und Zahmen Thiere. Zweyter Band. Zweyte Abtheilung. Ingolstadt. J. W. Krüll. 173 pp.

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**ERRATUM: THE SYNONYMY OF *C. DOESBURGI* DE CARLO
WITH *C. MONTEI* DE CARLO (HETEROPTERA: NEPIDAE)**

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Dr. Arnold Menke, retired NMNH curator, has pointed out an error in priority in my "Systematics of the New World waterscorpion genus *Curicta* Stål (Heteroptera: Nepidae)." On page 191, I synonymized *C. montei*, described by De Carlo in 1960, with *C. doesburgi*, also described by De Carlo but in 1967. Clearly, *C. montei* has priority. Therefore, I take this opportunity to correct this error.

Curicta montei De Carlo, 1960, Actas Trab. Congr. sud-am. Zool 3(4):48-49.

Curicta doesburgi De Carlo, 1967, Rev. Soc. Ent. Arg. 29(1-4):33. (1966).

NEW SYNONYMY.

Curicta doesburgi, Nieser, 1975, Studies Fauna Suriname and Guyanas 16(81): 131-132.

LITERATURE CITED

- De Carlo, J. A. 1960. Descripción de dos especies nuevas del género *Curicta* Stal y consideraciones sobre otras poco conocidas (Nepidae-Hemiptera). Actas Trab. Congr. sud-am. Zool. 3:47-51.
- De Carlo, J. A. 1967. Nuevas especies de los generos *Ranatra* y *Curicta*; referencias do otras poco conocidas. Rev. Soc. Ent. Arg. 29(1-4):30-36.
- Nieser, N. 1975. The Water Bugs (Heteroptera: Nepomorpha) of the Guyana region. Stud. Fauna Suriname and other Guyanas 59:1-310 + 24 plates.
- Keffer, S. L. 1996. Systematics of the New World waterscorpion genus *Curicta* Stål (Heteroptera: Nepidae). J. New York Entomol. Soc. 104(3-4):117-215.

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BOOK REVIEW

J. New York Entomol. Soc. 106(2-3):115-116, 1998

Las Mariposas de Chile—The Butterflies of Chile—Luis E. Peña G. and Alfredo J. Ugarte P. (English translation by Allen A. Boraiko). 1997. Editorial Universitaria, Santiago, 359 p. Fully illustrated. Price: \$35.00 (paperback).

This attractive guide covers the 169 species of butterflies known to occur in Chile, a meager number compared to the thousands of species that occur in neighboring Peru. Cut off from the faunas of the Amazon basin by the Andes and of the moist Pacific slope by the Atacama Desert, Chile is faunistically depauperate, yet biogeographically one of the most distinct regions of South America. In particular, there is a strong representation of peculiar Satyrinae, represented by 34 species whose affinities may lie more closely with austral temperate taxa than with their neotropical neighbors (such a distribution is akin to that displayed by many groups, including most prominently *Nothofagus* and *Araucaria* trees). Other diverse butterfly groups include the skippers and high Andean blues and whites. Two species deserving of special mention are *Argyrophorus argenteus*, a striking metallic silver satyrine that is difficult to believe is a real butterfly at first glance, and its golden counterpart, the skipper *Argopteron aureipennis*. These lovely creatures alone merit an expedition to Chile (no permits required!) for the aesthetically driven collector.

The book is well-organized, with facing pages of English and Spanish text. After a series of introductory essays by various notable lepidopterists (Gerardo Lamas, Art Shapiro and the authors), Part I begins with a short introduction to the order Lepidoptera that describes some systematic and morphological background. This is followed by a systematic checklist, a brief key to families (only for Chilean species), and a more detailed description of butterfly anatomy, life history and classification. Much of this information is similar to that provided at the beginning of most North American field guides, but may be a first for the Spanish-speaking lay readership for whom 50% of the book is intended.

Part II contains instructions for making a butterfly collection, including methods for capturing, killing, transporting, relaxing, spreading, storing and displaying specimens. The readers are encouraged to collect judiciously, not taking more specimens than necessary, and prepare and preserve them appropriately. There is also a nice section on rearing with lots of enthusiastic yet practical advice for the novice.

Part III (misleadingly called "Checklist") is the accounts of individual species, which represents about ⅓ of the book. The five families are presented in more or less traditional taxonomic order (Hesperiidae, Pieridae, Papilionidae, Lycaenidae, Nymphalidae). Each family begins with a description of major identifying features, habits and hostplants. Latin names, authors and dates are provided for all genera and species, as well as English and Spanish vernacular names and a short etymology of the binomen. Diagnostic features of adults include the wing span and a description

of prominent wing patterns. Habitat and behavior are described, sometimes with specific personal anecdotes about sites where the species has been encountered. Unfortunately, there is no description of phenology, which is marked in this temperate country (summer is from December to April, and my research suggests that the peak period for satyrines, at least, is in January and early February).

Each species description is accompanied by a color drawing of the recto surface of a spread specimen, with both sexes represented when they differ. Illustrations of verso surfaces are also provided for groups like the hairstreaks and satyrines which exhibit important diagnostic features there. These drawings are quite good, although I found the colors not to match as well as I would like in certain cases (for example, the markings on the underside of *Neomanaeas fractifascia* were much more yellow in the specimens I collected than the picture would suggest). Most of the more common species are also illustrated in color photographs of living specimens in their natural habitats. These photos are in some cases more useful for identifying specimens than the drawings, although others suggest that there is still useful work to be done in Chilean butterfly photography. All species accounts are also accompanied by a photo of "typical habitat," but these small images are generally not especially useful, as many look very similar to one another (basically, Chilean butterflies live in four main habitat types: *Nothofagus* forest, *Chusquea* bamboo thickets, desert arroyos, and treeless altiplano).

Distribution maps are also provided for each species, but their utility is limited by their small size. Further, the range of species is represented by a shaded blob, rather than by individual data points, making it difficult to determine specific localities. The book could have benefitted from a list of classic collecting sites and a larger map showing their locations. The accuracy of the distribution maps is also questionable: I saw a *Danaus erippus* at least 5° further south than the range map for that species indicates that it occurs.

From a taxonomic perspective, the book lists a number of recently described species of dubious authenticity, including several high-altitude lycaenids that are only known from one or a few specimens from a single locality. The authors themselves admit that they have done a seat-of-the-pants job with the systematics of the satyrines, the subject of rather rampant generic splitting by 19th and 20th Century revisers. There is clearly interesting phylogenetic work to be done on a number of these odd southern taxa.

The book concludes with a glossary of terms, a useful bibliography to the more recent and substantial systematic literature, and indices of Latin and common names. The book is printed on good-quality matte finish paper, and contains no technical flaws that I noticed. As a basic guide, I found it pleasant to read, useful in the field, and reasonably accurate in comparison to the collections at the Museo Nacional in Santiago and the Smithsonian. It is not a state-of-the-art monograph, but it certainly provides a good initiation to the butterflies of this remote corner of the globe. The reasonable price means that it will be accessible as a source of inspiration to enthusiasts to go forth and discover more, which, as Lamas notes in his introduction, is what the late Sr. Peña would have wished.

—Andrew V. Z. Brower, Dept. of Entomology, Oregon State University, Corvallis, OR 97331.

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The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

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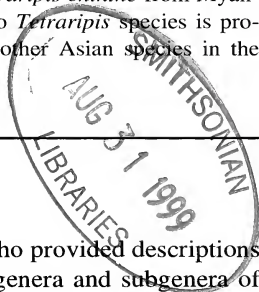
NOTES ON ASIAN VELIINAE (HETEROPTERA: VELIIDAE), WITH DESCRIPTIONS OF THREE NEW SPECIES

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Abstract.—Three new species of Veliinae from southeastern Asia are described and their key characters illustrated: *Velia (Haldwania) tomokunii* from Nepal, *Tetraripis chinthe* from Myanmar (Burma), and *Tetraripis drescheri* from Java. A revised key to *Tetraripis* species is provided, plus additional distributional records and clarifications for other Asian species in the genera *Tetraripis*, *Angilia*, and *Angilovelina*.



The Asian Veliinae were reviewed by Andersen (1981), who provided descriptions of several new species and a new genus, and a key to the genera and subgenera of Veliinae of the world. Since then, Zettel (1995) has proposed two new Bornean species in the genus *Tetraripis*, Thirumalai and Dam (1996) have given distributional notes on *Tetraripis* with a key to the known species, and Zettel & Hecher (in press) are in the process of describing three new species of *Angilia* and producing a key to the Oriental species.

In this paper we describe one new species of *Velia (Haldwania)* and two new species of *Tetraripis*, and give distributional records and notes on previously described taxa in the genera *Tetraripis*, *Angilia*, and *Angilovelina*, mainly based on material in the Polhemus collection. Our specimens of *Angilia* collected in Borneo are being treated by Zettel & Hecher (in press).

Much of the material dealt with in this paper comes from the hill country of Nepal, Burma, and northern Thailand along the southern margin of the Himalayan uplift, an area of intermingling for veliine biotas typical of both temperate and tropical Asia. At higher elevations in this region one finds members of the predominantly temperate genus *Velia*, including the new species *V. tomokunii* described herein. These *Velia* species occur at the eastern range limit of the genus as a whole, and seem to be localized around particular mountains, such as *V. sinensis* Andersen on Mt. Emei Shan in southern China. At lower elevations one encounters species of *Angilia* and *Tetraripis*, the former occurring as localized colonies often associated with spring outflows, and the latter more common and widespread, at least in Burma, but often easily overlooked due to their nocturnal habits.

All measurements are given in millimeters, and are averages unless otherwise indicated. CL numbers following certain localities refer to a coding system used by the authors to cross-reference specimens and collection data.

Genus *Velia* Latreille, 1804***Velia* (Haldwania) tomokunii** new species

Figs. 1-4

Description. *Apterous male.*

Size. Apterous male, length 6.04–6.49 mm (mean = 6.33 mm, $n = 5$); width 1.78–2.04 mm (mean = 1.92 mm, $n = 5$).

Color. Ground color blackish brown, with extensive yellow brown to brown markings; venter tinged with brown, abdominal venter medially orange brown. Head black, tinged with orange brown ventrally; rostrum testaceous on basal three segments, piceous distally. Pronotum with anterior lobe broadly yellowish brown medially, bordered by frosty grey pruinosity; collar blackish brown, disc orange brown. Metanotum, abdominal tergite I extensively marked with frosted grey, tergite II frosted grey all but medially, tergites III, V, VI laterally marked with triangles of frosted grey. Legs and antennae light brown to brown.

Structural characters. Apterous male: Head of moderate length, strongly declivant anteriorly; length 0.72; width of eye/interocular space, 0.25/0.39. Pronotum length: width, 1.39: 1.50. Abdominal tergites I–VI subequal in length (0.33–0.44), VII longer (0.67). Abdominal venter set with short appressed setae; sternite VII unmodified except for two (1 + 1) small deep depressions anteriorly on either side of midline, almost straight postero-medially and set with posteriorly directed short setae. Legs clothed with short setae, all femora beneath sparsely set with very fine moderately long setae; antennae set with short setae and scattered longer setae. Legs armed, but not modified; posterior trochanter armed with 8–10 small black denticles; hind femur weakly tumid, not incrassate, with two irregular rows of black pegs (black tapering spines) over entire length, about 45 total, dorsal row with one larger spine at basal $\frac{2}{5}$, another at distal $\frac{3}{4}$ followed by 6 spines of decreasing length distally; all tibiae straight, or nearly so; anterior tibia with short grasping comb, about $\frac{1}{6}$ the length of the tibia. Antennal formula I:II:III:IV; 1.50: 0.94: 1.00: 0.94. Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2, tarsal 3 of fore leg, 1.94: 1.83: 0.14: 0.20: 0.44; of middle leg, 2.66: 1.89: 0.08: 0.83: 0.78; of hind leg, 2.66: 2.94: 0.11: 0.78: 0.78.

Abdominal terminalia as shown in Figures 1–4; genital segments unmodified. Proctiger with two rounded lateral ears (Fig. 4). Paramere large, elongate, medially with a lamina (Figs. 1, 2). Endosomal sclerites as in Fig. 3.

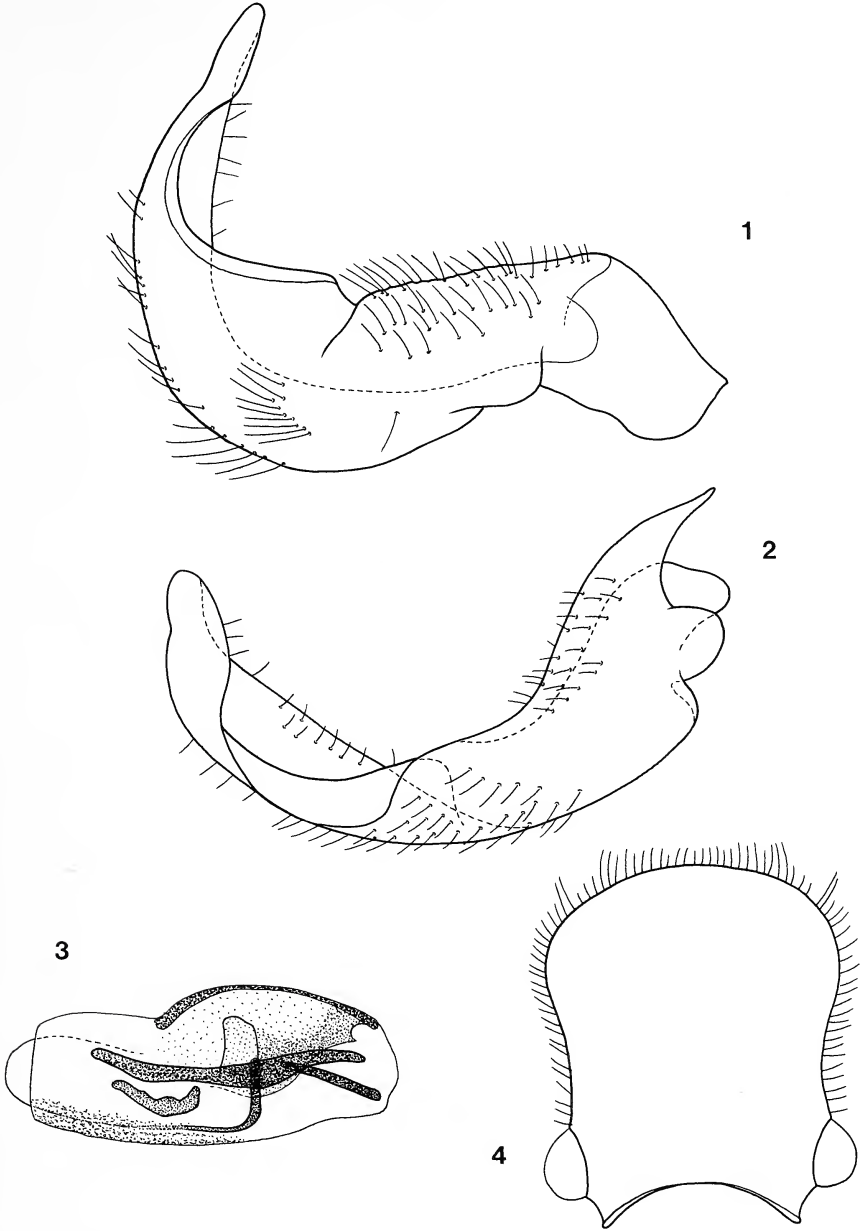
Apterous female. Length 6.40–6.67 mm (mean = 6.51 mm, $n = 5$); width 1.96–2.13 mm (mean = 2.06 mm, $n = 5$). Very similar to apterous male in most respects, but slightly more robust. Terminal abdomen with connexival angles divergent, weakly acuminate; proctiger rather large, broadly rounded posteriorly. Fore tibia without grasping comb; hind trochanter without pegs; hind femur with two rows of short black pegs, about 25 total.

Macropterous form. Unknown.

Etymology. The name “tomokunii”, a patronymic, honors Masaaki Tomokuni for his many contributions to the study of Heteroptera, as well as the collection of the only known specimens of this interesting species.

Distribution. Nepal.

Discussion. *Velia tomokunii* n. sp. is superficially most similar to *V. sinensis* An-



Figs. 1–4. *Velia tomokunii*. 1. Male right paramere, lateral view. 2. Male right paramere, top view. 3. Male endosoma, lateral view. 4. Male proctiger, top view.

dersen, but may be separated by the equally short female connexival angles directed posterolaterally rather than posterodorsally; all other species of the subgenus *Haldwania* have longer connexival angles. In general, *V. sinensis* is a longer and proportionally narrower species than *V. tomokunii*, and males of the two species may be separated by the structure of the connexival margins, which are straight in *V. sinensis*, tapering evenly and convergently in a posterior direction and not curving inward at their posterolateral angles, but weakly sinuate in *V. tomokunii*, bowing gently inward adjacent to abdominal tergites III and VI, then gently outward adjacent to tergites V and VI, and finally curving more sharply inward toward the genital capsule at their posterolateral angles. In addition, males of *V. tomokunii* have lateral pruinose patches on abdominal tergites II, III, V, and VI, while such patches are present only on tergites II, V, and VI in *V. sinensis*. The endosomal sclerites are also different in the two species (Fig. 3).

Velia tomokunii also resembles *V. championi* Tamanini in having the connexival angles flared outward posteriorly, however *V. tomokunii* is smaller in size, the middle leg has a shorter second tarsal segment in relation to the third (10/8 vs. 12/8), and the hind tibia has fewer spines (ca. 40 vs. ca. 70). In addition, the male parameres are slightly different (Figs. 1, 2), and the complement of endosomal sclerites is quite different (Fig. 3; compare with Fig. X of Tamanini, 1955).

In his characterization of the subgenus *Haldwania*, Andersen (1981: 352) states, concerning the hind legs, "trochanter unarmed" but male specimens from the type series of *V. (H.) championi* in the Polhemus collection (obtained on exchange from Tamanini and the BMNH) clearly possess such pegs, as does the male holotype of *V. (H.) sinensis*.

Material examined. Holotype, apterous male, NEPAL, **Ramechchap Dist.**, Thodung, 3100 m., 14 October 1979, M. Tomokuni (NSMT). Paratypes: NEPAL, **Ramechchap Dist.**: 4 males, 5 females, same data as holotype (NSMT, USNM, JTPC).

Genus *Tetraripis* Lundblad, 1936

***Tetraripis chinthe* n. sp.**

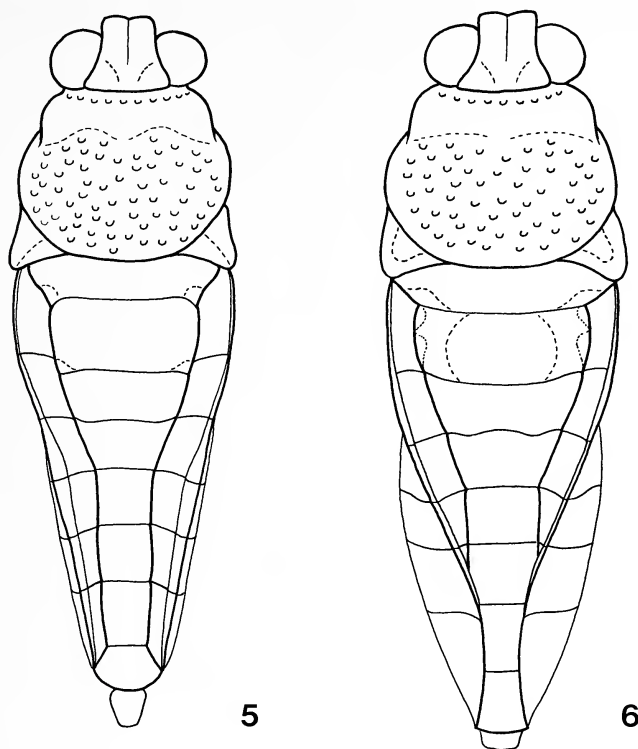
Figs. 5, 7

Description. *Apterous male.*

Size. Apterous male, length 3.72–4.11 mm (mean = 3.92 mm, $n = 10$); width 1.22–1.39 mm (mean = 1.33 mm, $n = 10$).

Color. Ground color light brown, with both lighter yellowish and darker brown markings; venter mostly yellowish brown, tinged with brown. Head light brown, tinged with brown ventrally; rostrum luteous on basal three segments, piceous distally. Pronotum with anterior lobe broadly yellowish brown medially, narrowly bordered by tomentum (frosted grey pruinose); females with connexival margins dark, especially the posterolateral angles; collar, disc mostly yellowish brown, tinged with darker brown. Abdominal tergite I posterolaterally, II laterally tomentose. Legs, antennae light brown, marked with darker brown forming annuli or interrupted annuli on antennal segments 1 and 2, all femora and tarsi.

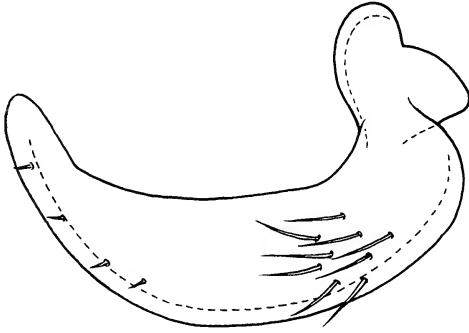
Structural characters. Apterous male: Head of moderate length, strongly declivant anteriorly; length 0.44; width of eye/interocular space, 0.28/0.28. Pronotum length: width, 0.94: 1.28. Abdominal tergites I short (0.22), tergites II, VII longer (0.39),



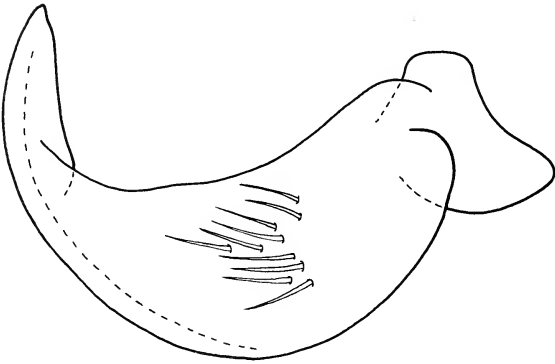
Figs. 5, 6. Females of *Tetraripis* species, dorsal habitus views, appendages omitted. 5. *T. chinthe*. 6. *T. drescheri*.

tergites III–VI subequal in length (0.25–0.28). Entire body (except venter), legs, antennae clothed with long erect dark colored setae; thoracic venter clothed with moderate length setae; abdominal venter set with short appressed setae and scattered longer setae. Sternite VII unmodified. Legs armed, not modified, middle tarsi very slightly bowed; posterior trochanter armed with 1 large (sometimes double) and several small black denticles; hind femur incrassate, with two irregular rows of black pegs (black tapering spines) over entire length, about 18 total, with one or two larger spines on basal $\frac{1}{2}$ of dorsal row, another at distal $\frac{2}{3}$ followed by 3 spines distally, ventral row with only 4–7 small pegs, mostly distal; hind tibia curved, set with two rows of short black pegs over entire length, a large inwardly directed sub-distal spine, and a smaller distal spine almost hidden by a distal comb; anterior tibia with short grasping comb, about $\frac{1}{4}$ the length of the tibia. Antennal formula I:II:III:IV; 0.83: 0.67: 0.55: 0.53. Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2, tarsal 3 of fore leg, 1.00: 1.05: 0.04: 0.03: 0.28; of middle leg, 1.50: 1.39: 0.05: 0.39: 0.72; of hind leg, 1.66: 1.78: 0.07: 0.14: 0.39.

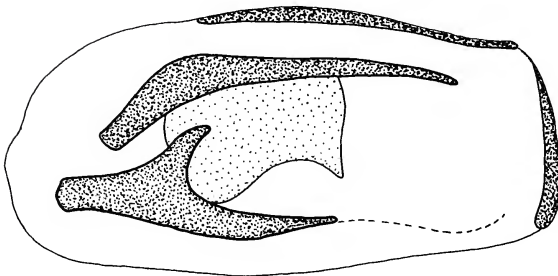
Abdominal terminalia with genital segments unmodified; proctiger without lateral ears; paramere large, falciform (Fig. 7). Endosomal sclerites similar to those shown in Fig. 9.



7



8



9

Figs. 7-9. *Tetraripis* species, male genital structures. 7. *T. chinthe*, right paramere, lateral view. 8. *T. drescheri*, right paramere, lateral view. 9. *T. drescheri*, endosoma, lateral view.

Apterous female. Length 4.11–4.55 mm (mean = 4.35 mm, $n = 10$); width 1.33–1.55 mm (mean = 1.45 mm, $n = 10$); body shape as in Figure 5. Very similar to apterous male in most respects, but slightly more robust. Terminal abdomen with connexiva steeply raised, often almost vertical distally, set with appressed pubescence on basal segments, long dark colored setae on all segments, restricted to margins on segments IV–VI, with a tuft of about 10 directed posteromedially from the posterior margin of segment IV; connexival angles straight, weakly acuminate; procitiger of normal size, narrowly rounded posteriorly. Fore tibia with very short grasping comb, about $\frac{1}{10}$ of tibial length; middle tarsi slightly bowed; hind trochanter without pegs; hind femur incrassate, with two rows of variably short black pegs, about 12–14 total, one slightly longer spine at distal $\frac{3}{5}$; hind tibia bowed, with two rows of short black pegs over entire length, a small sub-distal spine, and a smaller distal spine almost hidden by a distal comb.

Macropterous form. Unknown.

Etymology. The name “chinthe” (pronounced “chin-thee”), a noun in apposition, refers to the invincible lion-griffins guarding the Buddhist temples of Burma.

Distribution. Myanmar (Burma).

Discussion. *Tetraripis chinthe* differs from several other *Tetraripis* species by the male paramere shape, which is curved, broadened medially and acuminate distally; this immediately restricts comparison of *T. chinthe* to only *T. borneensis* Zettel, *T. doveri* Lundblad and *T. drescheri* n. sp. *Tetraripis chinthe* has a slightly narrower paramere than *T. borneensis*, a larger body size, and female sternite VII is shorter than V and VI combined (vs. equal in *borneensis*). *Tetraripis doveri* is a longer, narrower species with differently shaped abdominal terminalia in both sexes, is covered with very long, black, stiff setae (vs. mostly light colored, more slender setae in *T. chinthe* and *T. drescheri*), and lacks the several large stout spines found on the femora of *T. chinthe* and *T. drescheri*.

Tetraripis chinthe and *T. drescheri* are evidently sister species, having body segments, antennae and legs with similar proportions, and also closely resembling each other in coloration, hair covering and armature of the hindlegs, and deep pronotal punctation. The two species may be separated, however, by the differently shaped male parameres (Figs. 7, 8), the differently formed female connexiva (Figs. 5, 6), the much larger peg on the posterior trochanter of *T. chinthe* males, and the smaller number of hind femoral pegs in both sexes of *T. chinthe* (see descriptions). The connexiva are distally vertical (males) or reflexed (females) in *T. drescheri* (Fig. 6) while being open and angled slightly outward in *T. chinthe* (Fig. 5), and the female procitiger is slightly angled ventrad in *T. drescheri*, rather than horizontal as in *T. chinthe*.

Tetraripis chinthe is a widespread species in Burma, occurring in both lowland and highland habitats from the dry zone of central Burma into the western section of the Shan Plateau and south to the Bago Yoma hills. We encountered the species most typically in dark, sheltered sites under steep stream banks bearing tangles of roots, although at one locality (Magwe River, CL 4023) numerous individuals were found secreted under detritus or small logs along the sloping shore of a swift, clear stream. Once disturbed and forced from their hiding places, individuals skated in shady spots near shore for some time afterward, in a manner reminiscent of *Rhagovelia* species. We also suspect that *T. chinthe* is nocturnal, since specimens were

difficult to locate during daylight hours, while by contrast a very long series was taken at dusk along a shallow, clear stream draining into Inle Lake (CL 4021), the insects apparently having emerged from their hiding places along the stream banks with the onset of darkness. Similar nocturnal habits have been observed by the authors for other Veliinae, particularly Neotropical *Platyvelia* species occurring in the mountains of western Mexico.

Material examined (all apterous; nymphs not paratypes). Holotype, apterous male, MYANMAR (BURMA), **Shan Division**, channeled stream crossing road along E. side of Inle Lake, 7 km. S. of Nyaungshwe, 878 m. (2880 ft.), water temp. 24°C., 23 October 1998, 20°36.056'N, 96°56.789'E, CL 4021, J. T. & D. A. Polhemus (USNM). Paratypes: MYANMAR (BURMA), **Shan Division**: 45 males, 36 females, same data as holotype (USNM; AMNH; BPBM; NHMC; JTPC); 22 males, 16 females, 2 nymphs, Magwe River and swift tributary, below Magwe Village, 26 km. NW of Kalaw along Kalaw to Thazi road, 520 m. (1700 ft.), water temp. 29°C. (main river), 24 October 1998, 20°43.796'N, 96°29.477'E, CL 4023, J. T. & D. A. Polhemus (USNM). **Sagaing Division**: 4 males, 2 females, Kanbalu Division, Chatthin Wildlife Sanctuary, spring upslope of San Myaung Camp, 245 m. (800 ft.), water temp. 27.5°C. (80° F), 5–6 October 1998, 23°31.828'N, 95° 38.811'E, CL 4001, J. T. & D. A. Polhemus (NHMC, USNM); 6 males, 9 females, Kanbalu Township, Chatthin Wildlife Sanctuary, pools along stream channels at Kinsan Camp, 200 m. (650 ft.), water temp. 28°C. (81° F), 12–14 October 1998, 23°33.017'N, 95° 34.851'E, CL 4009, J. T. & D. A. Polhemus (USNM); 3 males, 3 females, Kanbalu Township, Chatthin Wildlife Sanctuary, pools along Mahaga Chaung stream, 1.5 km. E. of San Myaung Camp, 215 m. (700 ft.), water temp. 26°C., 13 October 1998, 23°31.620'N, 95° 39.619'E, CL 4010, J. T. & D. A. Polhemus (USNM). **Mandalay Division**: 1 male, 1 female, Maymyo Township, Gelaung River at Pwe Kauk Falls, 8 km. E. of Maymyo, 1005 m. (3300 ft.), water temp. 24.5°C., 19 October 1998, 22°03.523'N, 96°31.956'E, CL 4012, J. T. & D. A. Polhemus (USNM); 8 males, 11 females, Maymyo Township, small clear stream nr. Paungdaw Village, Maymyo Reserved Forest, 8 km. S. of Maymyo, 975 m. (3200 ft.), water temp. 22.5°C., 20 October 1998, 16:30–17:30 hrs., 21°58.199'N, 96°25.840'E, CL 4014, J. T. & D. A. Polhemus (USNM); 28 males, 15 females, 4 nymphs, Myitsone River, 50 km. NW of Kalaw along Kalaw to Thazi road, 425 m. (1400 ft.), water temp. 35°C., 25 October 1998, 20°48.457'N, 96°21.610'E, CL 4026, J. T. & D. A. Polhemus (USNM). **Bago Division**: 1 female, Bago Yoma, Sein Yai Forestry Camp, 1700 m, 29 October 1998, H. Schillhammer (36) (NHMW).

***Tetraripis drescheri* n. sp.**

Figs. 6, 8, 9

Description. *Apterous male.*

Size. Length 4.05–4.16 mm (mean = 4.11 mm, n = 2); width 1.28–1.33 mm (mean = 1.30 mm, n = 2).

Color. Ground color brown, with lighter yellowish to yellow brown markings; venter tinged with yellowish brown, abdominal venter medially yellowish. Head brown, tinged with yellowish ventrally; rostrum luteous on basal three segments, piceous distally. Pronotum with anterior lobe broadly yellowish brown medially,

narrowly bordered by tomentum (frosted grey pruinose); collar brown, disc mostly yellowish. Abdominal tergite I posterolaterally, II laterally tomentose. Legs, antennae light brown, marked with darker brown.

Structural characters. Apterous male: Head of moderate length, strongly declivant anteriorly; length 0.43; width of eye/interocular space, 0.27/0.29. Pronotum length: width, 0.97: 1.26. Abdominal tergite I short (0.22), tergites II, VII longer (0.43), tergites III–VI subequal in length (0.23–0.25). Entire body (except venter), legs, antennae clothed with long erect light colored setae; thoracic venter clothed with moderate length setae; abdominal venter set with short appressed setae and scattered longer setae. Sternite VII unmodified. Legs armed, not modified, middle tarsi slightly bowed; posterior trochanter armed with 1 modest and 2 small black denticles; hind femur incrassate, with two irregular rows of black pegs (black tapering spines) over entire length, about 25 total, with two larger spines on basal $\frac{1}{2}$ of dorsal row, another at distal $\frac{2}{3}$ followed by 4 spines distally; hind tibia curved, set with two rows of short black pegs over entire length, a prominent sub-distal inwardly directed spine, and a shorter distal spine almost hidden by the distal comb; anterior tibia with short grasping comb, about $\frac{1}{4}$ the length of the tibia. Antennal formula I:II:III:IV; 0.94: 0.58: 0.54: 0.48. Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2, tarsal 3 of fore leg, 0.97: 1.12: 0.04: 0.03: 0.32; of middle leg, 1.55: 1.44: 0.05: 0.36: 0.76; of hind leg, 1.73: 1.80: 0.07: 0.18: 0.50.

Abdominal terminalia as shown in Figures 8, 9; genital segments unmodified. Proctiger without lateral ears. Paramere large, falciform, shape as in Fig. 8. Endosomal sclerites as in Fig. 9.

Apterous female. Length 4.22 mm (mean = 4.22 mm, $n = 2$); width 1.39–1.50 mm (mean = 1.44 mm, $n = 2$). Very similar to apterous male in most respects, but slightly more robust. Terminal abdomen with connexiva vertical basally, reflexed over abdominal tergites distally, set with appressed pubescence on basal segments, and long light colored setae on all segments, more numerous along the margins of segments VI–VII and directed posteromedially; connexival angles straight, weakly acuminate; proctiger of normal size, narrowly rounded posteriorly. Fore tibia with very short grasping comb, about $\frac{1}{10}$ of tibial length; hind trochanter without pegs; hind femur incrassate, with two rows of short black pegs, about 22 total, one slightly longer spine at distal $\frac{2}{3}$; hind tibia bowed, with two rows of short black pegs over entire length, a small sub-distal spine, and a smaller distal spine almost hidden by a distal comb.

Macropterous form. Unknown.

Etymology. The name “drescheri”, a patronymic, honors F. C. Drescher for his excellent field work, resulting in many interesting collections of aquatic Heteroptera from Java.

Distribution. Indonesia, West Java.

Discussion. *Tetralipis drescheri* n.sp. is superficially most similar to *T. doveri* Lundblad, but may be separated by the brown rather than blackish ground color, shorter antennae and legs, shorter body, and especially by the body covering of light colored setae rather than the long stiff black setae seen in *T. doveri*. *Tetralipis drescheri* is very closely related to *T. chinthe*; see discussion under the latter.

Material examined. Holotype, apterous male, INDONESIA, Java, Jawa Barat Prov., Res. Cheribon, N. O. I. Tjideres, 100 m., July 1937, F. C. Drescher (MBBJ).

Paratypes: INDONESIA, Java, **Jawa Barat Prov.**: 1 male, 2 females, same data as holotype (MBBJ, JTPC).

Tetraripis asymmetricus Polhemus & Karunaratne

Teraripis asymmetricus Polhemus & Karunaratne in Polhemus 1980: 99 (Type, apterous male, Sri Lanka, Kitulgala, USNM)

Distribution. Sri Lanka; south India.

Discussion. Thirumalai & Dam (1996) recently reported *Teraripis asymmetricus* from southern India. Many years ago, one of us (JTP) also noted a specimen from southern India in the Snow Entomological Museum collections at the University of Kansas, but had no previous occasion to report it.

In the original description (Polhemus & Karunaratne, 1980), it was not mentioned that there are two forms of apterous females in this species, one with the distal connexiva reflexed and touching over tergite VII, and the distal abdominal tergites narrow, compressed, and longitudinally carinate, the other with the distal connexiva vertical, and distal abdominal tergites wider and of the usual form. In all other respects these dimorphic females are similar, and all have a short grasping comb.

Material examined. SOUTH INDIA, Yarkand: 1 apterous male, Shevaroy Hill, 4000 ft. (1220 m), February 1955, P. S. Nathan (SEMC).

Tetraripis borneensis Zettel

Teraripis borneensis Zettel 1995: 26 (Type, apterous male, Borneo, East Malaysia, Sarawak, NHMW)

Distribution. Borneo, East Malaysia, Sarawak.

Discussion. The type series of *Tetraripis borneensis* consists of eight apterous males and two apterous females from three localities in Sarawak, in southwestern Borneo. Through the kindness of Herbert Zettel we were able to study specimens to complete the key to species.

Material examined. MALAYSIA, Borneo, Sarawak: 1 apterous male, 1 apterous female, ca. 40 km SE Kapit, March 1994, J. Kodada (JTPC, NHMW).

Tetraripis doveri Lundblad

Teraripis doveri Lundblad 1936: 56 (Type, apterous male, West Malaysia, Perak, BMNH)

Distribution. West Malaysia, Perak, Kelantan.

Discussion. The type series of *Teraripis doveri* consists of an apterous male and an apterous female, and to our knowledge, no additional specimens have been reported since the original description. It is therefore significant that among our collections from peninsular Malaysia is a series from Kelantan, listed below. These specimens were taken from deep, dark pockets beneath steep banks and boulders along a modest sized stream shaded by a disturbed primary gallery forest, and the insects were dislodged from their secluded hiding places only with considerable effort. In this respect, the habits of *T. doveri* were very similar to those of the Burmese *T. chinthe*, discussed previously, and this, combined with their obvious negative phototropism,

leads us to hypothesize that *T. doveri* also displays a primarily nocturnal activity pattern.

Material examined. WEST MALAYSIA, **Kelantan:** 2 apterous males, 3 apterous females, waterfall 10 km NW of Pasir Puteh, CL 2084, 21 August 1985, J. T. & D. A. Polhemus (JTPC).

Tetraripis kodadai Zettel

Teraripis kodadai Zettel 1995: 27 (Type, apterous male, Borneo, East Malaysia, Sarawak, NHMW)

Distribution. Borneo, East Malaysia, Sarawak.

Discussion. The type series of *Tetraripis kodadai* consists of two apterous males, one apterous female, and a macropterous female, from two localities in Sarawak, in southwestern Borneo. To this we can add additional material from another Sarawak locality.

Material examined. MALAYSIA, Borneo, **Sarawak:** 3 apterous males, 3 apterous females, Tapah River, 16 km NW of Bau, CL 2052, 10 August 1985, J. T. & D. A. Polhemus (JTPC).

Tetraripis ravana (Kirkaldy)

Rhagovelia ravana Kirkaldy 1901: 309; 1902: 64; Distant 1903: 172 (Syntypes, apterous and macropterous males and females, Sri Lanka, Peradeniya).

Teraripis ravana Lundblad 1936: 53.

Distribution. Sri Lanka (Ceylon).

Discussion. At least part of the type series of *Teraripis ravana* has been located in the collections of Snow Entomological Museum at the University of Kansas. Among the specimens, all of which bear added green labels stating "The G. W. Kirkaldy Collection now Univ. Kansas Coll.," is a card-mounted macropterous female, with a type label in Kirkaldy's handwriting indicating a male. This long card also has two glue spots in addition to the remaining female, indicating the two specimens have been removed or lost, and probably one of these was the male referred to on the type label. Lundblad may have borrowed these types, but it is unlikely that he soaked the two missing specimens off of the card, because his figures were based on Horn material from Nalanda, Ceylon. The macropterous female is here selected as lectotype, and so labelled (see below). The male structures and female habitus were well illustrated by Lundblad (1936), so there seems to be no question as to the identity of this species.

Material examined. SRI LANKA [CEYLON]: 1 macropterous female, on a card that previously had two other specimens glued to it, with two labels, "Peradeniya, Ceylon" and "Rhagovelia ravana Kirkaldy, male (symbol) Type"—the remaining female is here designated as lectotype (SEMK); 1 apterous female, 1 nymph, both on one card, with three labels, "Peradeniya, E. E. Green", "Rhagovelia ravana Kirk., Cotype 1901" and a red label "Cotype No. 44364, USNM"—here designated as paralectotype (USNM); 3 apterous females, Peradeniya, Ceylon, 13.VII.20, ex. Torre-Bueno Collection (SEMK); 2 apterous males, 4 apterous females, Monaragala, 2 July 1970, P. B. Karunaratne (JTPC).

KEY TO THE SPECIES OF *TETRARIPIS*

1. Hind tibia of both sexes with at most a small sub-distal spine not nearly as long as half the tibial width in males, much smaller in females; Sri Lanka *T. ravana* (Kirkaldy)
- Hind tibia of both sexes with a prominent sub-distal spine at least as long as half the tibial width in males, slightly smaller in females 2
2. Male genitalia asymmetrical; female usually with abdominal tergite VII compressed laterally, carinate medially, projecting posteriorly; Sri Lanka and southern India *T. asymmetricus* Polhemus & Karunaratne
- Male genitalia symmetrical; female never with abdominal tergite VII compressed laterally nor carinate medially 3
3. Male parameres parallel sided, rounded distally; sternite V with two prominent posteriorly directed tubercles; female connexival segment V distinctly tumid at posterolateral angle, forming a swelling on interior (medial) surface; Borneo *T. kodadai* Zettell
- Male parameres falciform; sternite V without prominent posteriorly directed tubercles; female connexival segment V may be slightly thickened along edge, but not tumid at posterolateral angle, without a swelling on interior (medial) surface 4
4. Posterior femur of male (and usually female) with all large pegs evenly graded in length, without great size disparity between adjacent pegs; female connexival segment VII angulate but without spines; peninsular Malaysia *T. doveri* Lundblad
- Posterior femur of male (and usually female) with at least one large peg of much greater size than adjacent pegs; female connexival segment VII sharply angulate, with at least small spines 5
5. Male paramere with inner margin of blade sinuate, broadened medially; female with posterior margins of connexival segment VII and tergite VII about even; Borneo *T. borneensis* Zettell
- Male paramere with inner margin of blade evenly curved, not broadened medially; female with posterior margins of connexival segment VII extending distally beyond tergite VII, to about middle of tergite VIII 6
6. Ground color brown to blackish brown; upper margin of female connexival segment III with ca. 20 stout long black setae arising from posterior half, directed posteromedially; posterior femur of male set with about 18 pegs, of female with about 14 pegs; Myanmar (=Burma) *T. chinthe* n. sp.
- Ground color yellowish brown; upper margin of female connexival segment III with only a few long setae; posterior femur of male set with about 25 pegs, of female with about 22 pegs; Java *T. drescheri* n. sp.

Genus *Angilia* Stål, 1865*Angilia* (*Adriennella*) *bispinosa* Andersen

Angilia bispinosa Andersen 1981: 345 (Type, macropterous male, north Thailand, ZMUC)

Distribution. Myanmar (=Burma), Shan Division; north Thailand.

Discussion. We have collected this species at the type locality, Fang Horticultural Station in far northern Thailand. In addition, we have now found this species near Inle Lake, in northwestern Burma. The Burmese series was taken from dark holes under the steep banks of a moderate sized, spring-fed stream.

Material examined. MYANMAR (BURMA), **Shan Division:** 1 macropterous male, 4 macropterous females, spring and streams nr. Shwelinban village, NE of Inle Lake, 4.5 km. NE of Nyaungshwe, 900 m. (2950 ft.), water temp. 22.5°C., 23 October

1998, 20°41.657'N, 96°57.759'E, CL 4018, J. T. & D. A. Polhemus (JTPC). THAILAND, **Chiang Mai Prov.:** 1 macropterous male, 2 macropterous females, Fang Horticultural Station, trib. to Nam Chai River, 500 m, CL 2202, 15 November 1985, J. T. & D. A. Polhemus (JTPC).

Angilia (Adriennella) orientalis Andersen

Angilia orientalis Andersen 1981: 343 (Type, macropterous male, north Thailand, ZMUC)

Distribution. Myanmar (=Burma), Shan Division; Thailand; Hong Kong.

Discussion. We have taken this species in far northern Thailand at Fang Horticultural Station, the type locality, and at a second locality further to the south. In addition, we can now report this species from Burma, having taken a series near Maymyo, on the western Shan Plateau. This Burmese series was collected from dark, secluded spots formed by overhanging vegetation or tangles of flood debris along the banks of small, spring-fed streams.

Material examined. MYANMAR (BURMA), **Mandalay Division:** 1 macropterous male, 2 macropterous females, 1 immature, Maymyo Township, spring outflows along headwaters of Nyaungkhangyi Chaung [=stream] above reservoir, Taungbo Reserved Forest, 7 km. N. of Maymyo, 1065 m. (3500 ft.), water temp. 22°C., 20 October 1998, 11:00–13:00 hrs., 22°05.371'N, 96°27.409'E, CL 4013, J. T. & D. A. Polhemus (JTPC). THAILAND, **Chiang Mai Prov.:** 1 macropterous male, Mae Sa waterfall, 7 km W. of Mae Rim, CL 2203, 18 November 1985, J. T. & D. A. Polhemus (JTPC); 1 macropterous female, Fang Horticultural Station, trib. to Nam Chai River, 500 m, CL 2202, 15 November 1985, J. T. & D. A. Polhemus (JTPC).

Angilia (Adriennella) philippiensis Drake & Hoberlandt

Angilia philippiensis Drake & Hoberlandt 1953: 223. (Type, macropterous male, Philippine Is., Mindoro, CAS)

Distribution. Philippine Is., Mindoro, Luzon.

Discussion. We have a specimen at hand that matches the original description plus the redescription of Andersen (1981), and is therefore presumed to be this species, which is rare in collections.

Material examined. PHILIPPINE ISLANDS, Luzon: 1 macropterous female, N. Ecija: Carranglan, Maringalo RFD Station, creek, 5 November 1976, A. A. Barroso (JTPC).

Angilia (Adriennella) trispinosa Andersen

Angilia trispinosa Andersen 1981: 350 (Type, macropterous female, north Sumatra, USNM)

Distribution. Indonesia, North Sumatra.

Discussion. The type locality of *Angilia trispinosa*, "Tg. Morawa," was presumed by Andersen to lie in peninsular Malaysia. In fact, it is located in northern Sumatra. This locality was fixed by D. A. Polhemus (1994: 9) in his revision of the gerriid genus *Cylindrostethus*, in which he showed that Tg. Morawa is an abbreviation for

Tanjung Morawa (also spelled Tandjong Morawa on some maps), which lies east of Medan, in the Deli Serdang district. *Angilia trispinosa* is presently known only from the type series of two females, and to our knowledge has not been collected since.

Genus *Angilovelina* Andersen, 1981

Angilovelina y-alba (Paiva)

Velia y-alba Paiva 1918: 20 (Type, macropterous female, Myanmar (=Burma), (NZSI))

Angilovelina y-alba Andersen 1981: 341.

Distribution. Myanmar (=Burma), Inle Lake; India, Assam; West Malaysia, Perak; northern Vietnam; Hong Kong.

Discussion. This species was originally described from Burma, but is widespread across Southeast Asia. The type locality of *Angilovelina y-alba*, the edge of Inle Lake at Fort Stedman, was recently visited by the authors in an unsuccessful effort to re-collect this species. We sampled several streams near the lake, but not the edge of the lake itself. Since only available specimens with habitat data have been collected from a rice paddy in Hong Kong and from a "Waiside pond" in West Malaysia (Perak Japah, from Andersen, 1981: 341; see new records below), it is possible that this may not be a stream dwelling insect, thus accounting for our failure to find it during our brief one day visit.

Material examined. HONG KONG: 1 brachypterous male, 1 brachypterous female, Wu Kwai Sha paddy, 26 March 1983, D. Dudgeon (JTPC). VIETNAM: 1 macropterous male, Tonkin, Hanoi, 30 Jan. 1918, Jeanvoine (JTPC).

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The following curators kindly provided access to specimens held under their care, or the institution listed is a repository of specimens (collection abbreviations are those used in the text): Dr. Robert Brooks, Snow Entomological Museum, Lawrence (SEMC); Drs. Richard Froeshner and Karl Krombein, National Museum of Natural History, Smithsonian Institution, Washington, D. C. (USNM); Bishop Museum, Honolulu (BPBM); National Zoological Survey of India, Calcutta (NZSI); Natural History Museum, Yangon [Rangoon] (NHMC); American Museum of Natural History, New York (AMNH).

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LITERATURE CITED

- Andersen, N. M. 1981. A new genus and descriptions of new Oriental species of the subfamily Veliinae (Hemiptera: Veliidae). *Ent. scand.* 12:339–356.
- Distant, W. L. 1903–1904. The fauna of British India including Ceylon and Burma. Rhynchota (Heteroptera), Vol. 2, 242 pp., Dec. 1903; xvii + 243–503 pp., April 1904.
- Kirkaldy, G. W. 1901–1902. Notes on the Division Veliaria (Rhynchota) (=Subfam. Velidae, Leth. & Sev.). *The Entomologist* 34:308–310, 1901; 35:63–64, 1902.
- Paiva, C. A. 1918. Aquatic Rhynchota from the southern Shan States. *Rec. Indian Mus.* 14: 19–32, 2 pls.
- Polhemus, D. A. 1994. Taxonomy, phylogeny and zoogeography of the genus *Cylindrostethus* in the Paleotropical region (Heteroptera Gerridae). *Bishop Museum Occ. Pap.* 38:1–34.
- Polhemus, J. T. 1980 Results of the Austrian–Ceylonese Hydrobiological Mission 1970, of the Institute of Zoology of the University of Vienna (Austria) and the Department of Zoology of the University of Sri Lanka, Vidyalkankara Campus, Kelaniya. Part XIX: Aquatic Semiaquatic Hemiptera of Sri Lanka from the Austrian Indo-Pacific Expedition 1970–71. *Bull. Fish. Res. Stn., Sri Lanka* 29:89–113, 1979.
- Tamanini, L. 1955. IV Contributo allo Studio del Genere *Velia* Latr. con la descrizione de quattro nuove entita (Hem. Heter. Veliidae). *Boll. Soc. Entomol. Italiana* 85:35–44.
- Thirumalai, G. & D. Dam. 1996. A new record of the genus *Tetraripis* Lundblad (Rhagoveliinae: Veliidae: Heteroptera) from India with a key to the known species. *Hexapoda* 8: 67–70.
- Zettel, H. 1995. Zwei neue Arten der Gattung *Tetraripis* Lundblad aus Borneo (Heteroptera: Veliidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 47:25–30.
- Zettel, H. & Ch. Hecher. in press. Notes on the Veliidae (Heteroptera) of Borneo: 1. Three new species of *Angilia* Stål, 1865, with a key to the Oriental species. *Ann. Naturhist. Mus. Wien*.

***RHYPAROCHROMUS SATURNIUS* (ROSSI) (HETEROPTERA:
LYGAEOIDEA: RHYPAROCHROMIDAE), A PALEARCTIC SEED
BUG NEWLY DISCOVERED IN NORTH AMERICA**

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Abstract.—The Palearctic rhyparochromid *Rhyparochromus saturnius* (Rossi) [Lygaeoidea] is reported for the first time in North America based on collections from 17 counties in California. Literature pertaining to this adventive species is reviewed, notes on its habits are given, and descriptions and photographs of the adult and fifth-instar nymph are provided to help distinguish it from other North American Rhyparochromidae. It is speculated that *R. saturnius* was introduced in international commerce originating from the Mediterranean Region, most likely Italy or nearby countries.

Key words: Heteroptera, Lygaeoidea, Rhyparochromidae, *Rhyparochromus saturnius*, North America, new record, California.

In April of 1998, three specimens of a rhyparochromid, collected in San Joaquin County, California, were submitted to the Systematic Entomology Laboratory (Agricultural Research Service, United States Department of Agriculture, Washington, D. C.) for identification. They proved to be *Rhyparochromus saturnius* (Rossi), a southern European species not known to occur in North America. Although the establishment of this species could not be confirmed based on these few specimens, additional evidence kindly provided by Larry A. Allen, an entomologist with the San Joaquin County Department of Agriculture, suggested that naturalized populations of this Palearctic species were present in at least one central California county.

In this paper, we give the first North American records for *R. saturnius*, review the literature pertaining to it, give notes on habits, and redescribe and provide photographs of the adult and fifth-instar nymph to help allow recognition of this species in the North American fauna.

The first documented U. S. specimen of *R. saturnius* was taken by Terry M. Allen in South Sacramento on 9 Oct. 1994. He later collected specimens on 9 Oct. 1995, 22 Sept. 1996, and 21 Nov. 1997. Additional material was taken by Larry A. Allen at Elk Grove, San Joaquin Co., Nov. 1996, April 1997, and August 1997. The August 1997 specimens collected by L. A. Allen (submitted to us by Alan Hardy, California Department of Agriculture, Sacramento) represent the material that first alerted us of a potential new U.S. and Western Hemisphere record for *R. saturnius*.

Since these initial collections, numerous other specimens have been discovered, including those taken in 1998 by L. A. Allen in yellow panel traps, Lindgren funnel traps for Asian longhorn beetle, Japanese beetle traps, and sticky pheromone traps set for monitoring gypsy moth, Oriental fruit moth, apple maggot, cherry fruit fly, Mediterranean fruit fly, and other common pests species in San Joaquin County.

Certainly, *R. saturnius* is not attracted to all of the specific pheromones used for monitoring these insects, but more simply these captures must reflect chance encounters by an abundant and widely dispersing bug. *Rhyparochromus saturnius* also has become a nuisance and frequently invades homes. It even has been found trapped in swimming pools. As common as this bug appears to be, however, it does not seem to be phototropic as are many other rhyparochromids. Not surprisingly, *R. saturnius* has attracted the attention of the newspaper and television media, and seems to have stimulated business for the local pest control industry, judging from the numerous pest control operator inquiries received (L. A. Allen, pers. comm.).

In August 1998, A. G. Wheeler, Jr. and the first author traveled to Stockton, California, to work with L. A. Allen to determine if *R. saturnius* was established. Our first few attempts to collect this species in the Stockton area indicated that it was common at most sites. At one locality (Stockton County Fairgrounds), *R. saturnius* was abundant on the ground under thick strawlike mats of a mowed grass or small grain. We estimate that 10 to 15 bugs per square foot (ca 0.09 m²) were present in some spots of an approximately two-acre field (nearly one hectare). At another site near the San Joaquin County Agriculture Commissioner's Building, several bugs were found under mats of a *Euphorbia* growing from cracks in sidewalks. Other collections in the Stockton area indicated that *R. saturnius* was generally common under mats of prostrate plants and grasses growing over curb sides. A few adults and late instars were found up on plants, although they were always more abundant on the ground. Specimens were found in a wide array of situations, including in and around patches of yellow starthistle, *Centaurea solstitialis* L. [Asteraceae], but we were unable to determine any particular host association.

Essentially, nothing is known about biology or hosts of *R. saturnius*, although its habits are presumed similar to those of other species in the genus. Another widespread species, *R. pini* (Linnaeus), is found in England on the ground beneath heather and heaths and among dead leaves and pine needles, where it feeds on fallen seeds. According to Southwood and Leston (1959), it overwinters as adults, emerging on mild days in spring. Mating occurs in late May and eggs are laid on the ground in litter or on woody stumps. First-generation adults begin appearing in early August, as do those of *R. saturnius* in California. Wagner (1961) reported *R. pini* under decaying logs and crawling on the ground, possibly associated with *Artemisia* (Asteraceae) and *Thymus* (Lamiaceae). Based on preliminary observations, it appears that *R. saturnius* overwinters as adults in protected places (L. A. Allen, pers. comm.) and is a generalist that feeds on numerous kinds of fallen seeds found over a wide range of dry or Mediterranean-like habitats typical of those found in central and southern California.

Rhyparochromus saturnius (Rossi)

(Figs. 1–5)

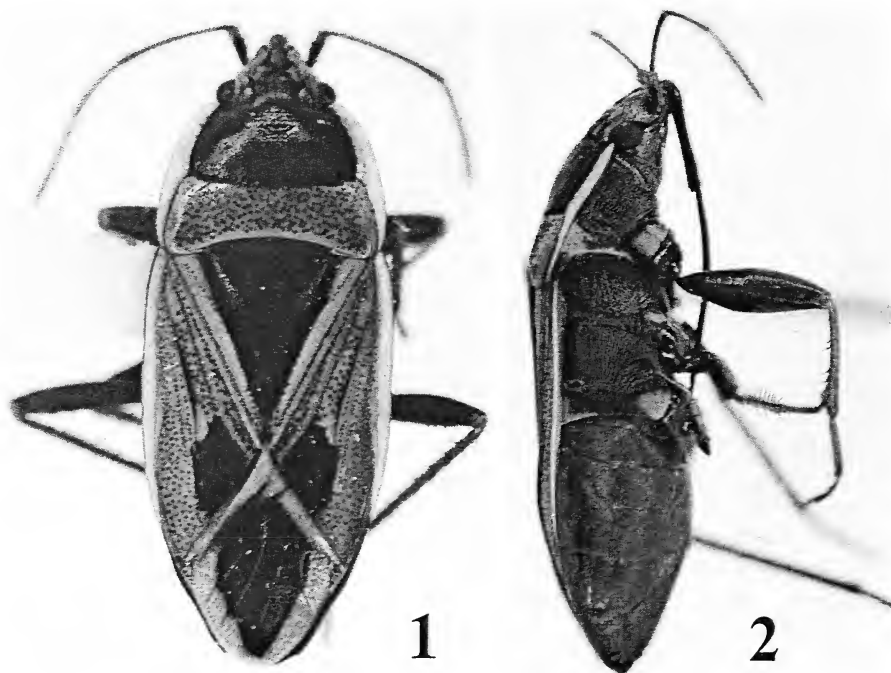
Cimex saturnius Rossi 1790: 245.

Pachymerus saturnius: Herrich-Schaeffer, 1835: 346.

Pachymerus rhombeus Fieber 1837: 346. Synonymized by Puton 1869: 16.

Pachymerus rhombimacula Costa 1843: 83. Synonymized by Puton 1874: 226.

Beosus saturnius: Fieber, 1861: 196.



Figs. 1, 2. *Rhyparochromus saturnius*. 1, Adult, dorsal aspect. 2, Adult, lateral aspect.

Aphanus saturnius: Lethierry and Severin 1894: 218.

Rhyparochromus (Xanthochilus) saturnius: Kiritschenko 1951: 286.

Raglius saturnius: Lindberg 1953: 84.

Rhyparochromus (Neoxanthochilus) saturnius: Wagner 1961: 94. See Slater (1964: 1334) for comprehensive bibliography.

Diagnosis. *Rhyparochromus saturnius* is readily distinguished from all other Nearctic Lygaeoidea by the combination of its relatively large size and distinct color pattern, particularly the brown-punctured hemelytra, with a large quadrate fuscous spot on the corium and a large rounded fuscous spot on the membrane (Figs. 1, 3). This species was previously placed in the paraphyletic family Lygaeidae, but is now assigned to the newly recognized Rhyparochromidae (Henry 1997), in the nominate subfamily Rhyparochrominae and tribe Rhyparochromini. Wagner (1961) placed *R. saturnius* in his subgenus *Neoxanthochilus*.

Description. *Adult male* ($n = 10$): Length 7.08–7.50 mm, width across middle of corium 2.60–2.80 mm. *Head*: Length 1.24–1.26 mm, width across eyes 1.30–1.38 mm, width of vertex 0.88–0.92 mm, width between ocelli 0.60–0.62 mm; black, thickly covered with recumbent silvery to golden, sericeous setae dorsally, more scattered to nearly glabrous on vertex near base; eight trichobothria present on dorsum, one on either side near posterior and anterior margins of eye, one on either side of tylus or clypeus, and the longest one on either side of vertex about the width of an eye toward middle. *Rostrum*: Length 4.20–4.24 mm (segment I, length 1.28–



Figs. 3, 4. *Rhyparochromus saturnius*. 3, Adult in ground litter. 4, Fifth-instar nymph on *Rumex* inflorescence.

1.32 mm; II, 1.32–1.36 mm; III, 1.04–1.08 mm; IV, 0.60–0.64 mm), extending to bases of metacoxae. *Antenna*: Segment I, length 0.52–0.56 mm; II, 1.34–1.36 mm; III, 1.08–1.18 mm; IV, 1.18–1.20 mm; reddish brown, with extreme bases of segments II–IV and basal $\frac{2}{3}$ of I black. *Pronotum*: Length 1.52–1.60 mm, basal width 2.32–2.56 mm, shiny, glabrous; anterior lobe black, impunctate; posterior lobe pale brown or tan, with scattered brown punctures; lateral explanate margins impunctate,

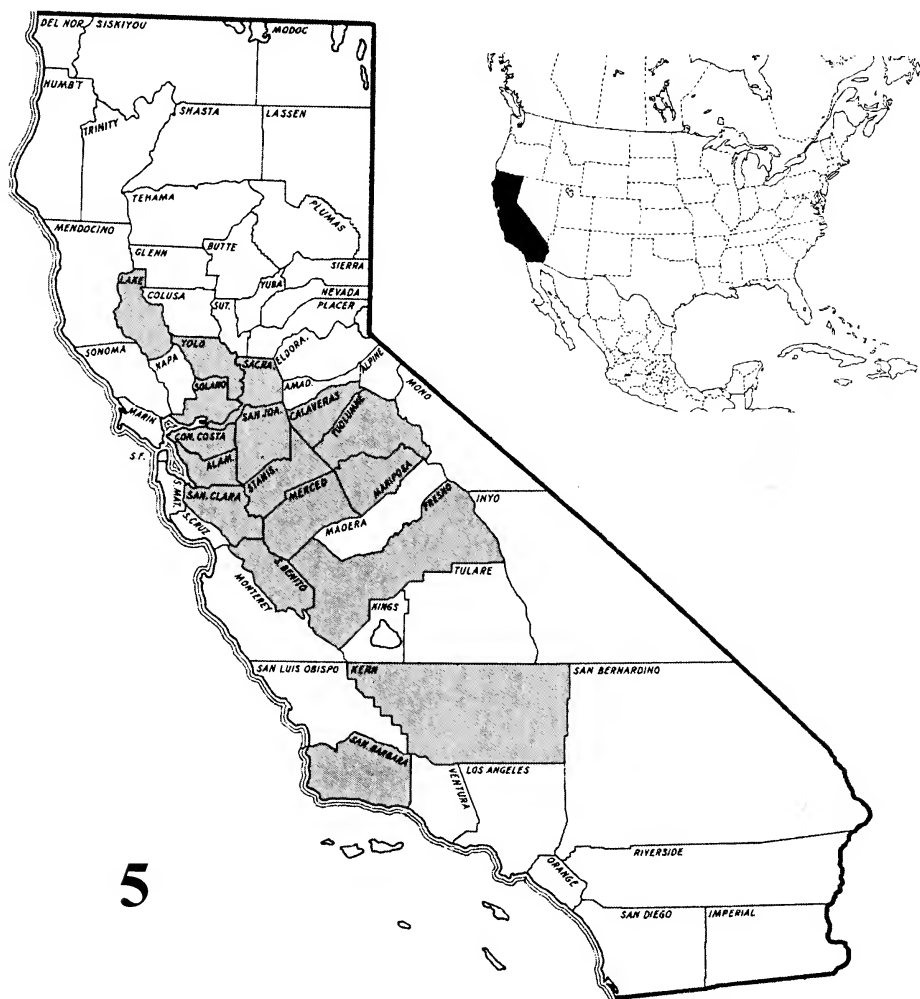


Fig. 5. County distribution of *Rhyparochromus saturnius* in California.

pale brown or tan; scutellum length 1.56–1.68 mm, basal width 1.40–1.44 mm, uniformly black and finely punctate. *Hemelytron*: Glabrous, pale brown or tan, with inner half of clavus and a large quadrate spot at inner angle of corium black, uniformly scattered with brown punctures, including linearly along all major veins; embolium impunctate, uniformly pale brown or tan; membrane white, with a large black central spot. *Ventral surface*: Mostly black, all acetabula and posterior margins of pro- and metapleura pale brown or tan. *Legs*: Femora black, except narrowly reddish-brown apices; tibiae reddish brown, metatibia often becoming more fuscous, all spines black; tarsi and claws reddish brown.

Adult female (n = 10; figs. 1–3): Length 7.08–8.08 mm, width across middle of corium 2.56–2.88 mm. *Head*: Length 1.20–1.43 mm, width 1.32–1.46 mm, vertex

0.88–0.96 mm. *Rostrum*: Length 4.28–4.58 mm (segment I, 1.28–1.42 mm; II, 1.40–1.44 mm; III, 1.04–1.12 mm; IV 0.60–0.68 mm). *Antenna*: Segment I, length 0.50–0.56 mm; II, 1.24–1.36 mm; III, 1.00–1.20 mm; IV, 1.02–1.12 mm. *Pronotum*: Length 1.50–1.68 mm, basal width 2.34–2.72 mm; scutellum length 1.58–1.72 mm, basal width 1.36–1.60 mm.

Fifth Instar (n = 3; fig. 4): Length 5.08–5.83 mm. Head black, eyes red. Antenna yellowish brown, segment IV darker brown, bases of segments I and III dark brown or black. Rostrum fuscous, extending to apices of metacoxae. Pronotum quadrate, lateral margins narrowly explanate; dark brown to black, with narrow sublateral margins and a wide band across base yellowish brown; scutellar area dark brown with median line narrowly yellow; wing pads extending to fifth abdominal segment, pale yellowish brown, with a broad dark-brown stripe through middle. Abdominal dorsum gray to dark brown, accented with red streaks, lateral margins and a quadrate spot on either side of abdominal scent gland openings II and III pale yellow to nearly white, scent gland opening I (basal opening) surrounded by a large quadrate fuscous marking (much larger than markings on II and III) and bordered on either side by a red-centered white band extending transversely to lateral margins; scent gland openings present between segments 4–5, 5–6, and 6–7. Ventral surface of head and thorax fuscous to black; abdominal venter grayish brown, streaked with red; segments 6, 7, and 8 each with a large, round, dark-brown spot along median line. Legs uniformly fuscous or dark brown.

Remarks. It is not surprising that *R. saturnius* has become established in California. Over the past nine years, it has been intercepted by APHIS/PPQ personnel more than 40 times at U. S. ports of entry, most frequently at Houston, Miami, and New York, primarily on pallets of tile and other ceramic products. Italy represents the origin of all but two of these interceptions. One non-Italian interception came from Spain and the other from the United Kingdom, the latter undoubtedly representing an intermediate stop from the Mediterranean area given that *R. saturnius* is not known to occur in the UK (Southwood and Leston 1959). Only three interceptions were from California ports, one at Long Beach from Italy in 1996 and two at San Diego in 1998, listed as originating in Mexico. If the latter records are accurate, they may indicate that *R. saturnius* is also established in Mexico. Our efforts to determine the origin of these Mexican shipments were unsuccessful.

Three other rhyparochromids, two of which are adventive in North America, also were found at several sites during our survey, but they were never as common as *R. saturnius*. *Emblethis vicarius* Horváth (Gonianotini), widespread in North, Central, and South America (Ashlock and Slater 1988), was found in three counties (Fresno, Lake, and San Joaquin); *Lamprodema maura* (Fabricius) (Megalonotini), known in North America only from California and Nova Scotia (Ashlock 1977) was collected in Contra Costa County; and *Megalonotus sabulicola* (Thomson) (Megalonotini), known in this hemisphere from the eastern and western United States and from Canada (Wheeler 1989, Asquith and Lattin 1991), was taken in four counties (Calaveras, Contra Costa, San Joaquin, and Yolo). From *R. saturnius*, *L. maura* is differentiated by the small size (4.20 mm or less), polished dorsum, black head, pronotum, and scutellum, fuscoredish hemelytra with a paler clavus, and pale membrane with a dark central cloud; *M. sabulicola* is distinguished by its small size (less than 5.50 mm), black head and pronotum, and fuscoredish hemelytra; and *E. vi-*

carius, slightly smaller than *R. saturnius*, is uniformly pale brown or tan, marked only with tiny dark spots over most of the dorsum, and the lateral margins of the pronotum and hemelytra are broadly explanate.

Distribution. *Rhyparochromus saturnius* is reported from Algeria, Bulgaria, Crimea, Egypt, France (including Malta), Germany, Greece, Israel, Italy (including Sardinia and Sicily), Morocco, Portugal, Russia, Spain (including Canary Islands), Syria, Tunisia, Turkey, and Yugoslavia (Slater 1964).

California (Fig. 5), including 17 counties (Alameda, Calaveras, Contra Costa, Fresno, Kern, Lake, Mariposa, Merced, Sacramento, San Joaquin, San Benito, Santa Barbara, Santa Clara, Solano, Stanislaus, Tuolumne, and Yolo counties), is a new record for the United States and the Western Hemisphere. Records from Kern and Santa Barbara counties are based on identifications furnished by T. A. Allen and are not listed below.

Material examined (all in National Museum of Natural History [NMNH] collection, Washington, D. C., except as noted). **CALIFORNIA:** **Alameda Co.:** 1 ♂, Livermore, 480', at N. Vasio Rd. & Dalton Ave., 37°44'01"N, 121°43'51"W, 14 Aug. 1998, T. J. Henry and A. G. Wheeler, Jr. [TJH & AGW]. **Calaveras Co.:** 3 ♂♂, 8 ♀♀, Valley Springs, 11–13 August 1998, L. A. Allen. **Contra Costa Co.:** 1 ♀, Near Discovery Bay, Rt. 4, 37°53'23"N, 121°37'24"W, 14 Aug. 1998, TJH & AGW. **Fresno Co.:** 5 ♂♂, 1 ♀, Rt. 33, at Firebaugh, 36°51'43"N, 120°27'44"W, TJH & AGW, under mats of *Chenopodium* sp. **Lake Co.:** 1 ♂ (5 late-instar nymphs), Rt. 29, Middletown, 10 Aug. 1998, AGW, on head of *Rumex crispus* L. [Polygonaceae]. **Mariposa Co.:** 2 specimens, Red Hills Recreation Area, June 1997, in pitfall trap, M. A. Wall (M.A. Wall collection). **Merced Co.:** 1 ♂, at Santa Nella, off Rt 5, 37°05'57"N, 121°00'54"W, 14 Aug. 1998, TJH & AGW. **Sacramento Co.:** 2 (specimens based on field notes, sex not determined), Hazelton St., near California Dept. Agric. Bldg., 11 Aug. 1998, L. A. Allen, TJH, & AGW. **San Joaquin Co.:** 30 ♂♂, 27 ♀♀, Stockton, San Joaquin County Fairgrounds, Airport Rd. & Charter, 37°56'23"N, 121°16'11"W, 11–13 Aug. 1998, TJH & AGW; 1 ♂, Stockton Airport, 12 Aug. 1998, L. A. Allen, TJH, & AGW; 1 ♀, Port of Stockton, 37°56'58"N, 121°19'56"W, 12 Aug. 1998, L. A. Allen, TJH, & AGW. **San Benito Co.:** 1 ♀ (1 late-instar nymph), Rt. 156, toward Hollister, near Santa Clara Co. line, 36°57'29"N, 121°23'00"W, TJH & AGW. **Santa Clara Co.:** 1 ♀, Rt. 152, 2 mi. W of Merced Co. line, 37°03'41"N, 121°13'50"W, TJH & AGW. **Solano Co.:** 1 ♂, Dixon, 38°27'28"N, 121°50'30"W, 12 Aug. 1998, L. A. Allen, TJH, & AGW. **Stanislaus Co.:** 1 ♀, at Westley Rd, Rt. 5, 37°32'31"N, 121°15'58"W, 14 Aug. 1998, TJH & AGW. **Tuolumne Co.:** 1 ♀, S. of "Chinese Camp," June 1997, M. A. Wall. **Yolo Co.:** 1 ♀, Port of Sacramento, West Sacramento, 38°33'42"N, 121°32'27"W, 13 Aug. 1998, L. A. Allen, TJH, & AGW.

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LITERATURE CITED

- Ashlock, P. D. 1977. New records and name changes of North American Lygaeidae (Hemiptera: Heteroptera: Lygaeidae). *Proc. Entomol. Soc. Wash.* 79:575–582.
- Ashlock, P. D. and Alex Slater. 1988. Family Lygaeidae Schilling, 1829. (= Infericornies Amyot and Serville, 1843; Myodochidae Kirkaldy, 1899; Geocoridae Kirkaldy, 1902.). Pp. 167–245. *In*: Henry, T. J. and R. C. Froeschner (eds.), *Catalog of the Heteroptera, or true bugs, of Canada and the continental United States*. E. J. Brill, Leiden and New York, 958 pp.
- Asquith, A. and J. D. Lattin. 1991. A review of the introduced Lygaeidae of the Pacific Northwest, including the newly discovered *Plinthisus brevipennis* (Latreille) (Heteroptera: Lygaeidae). *Pan-Pac. Entomol.* 67:258–271.
- Costa, A. 1843–1862. *Cimicum regni Neapolitani centuria*. *Atti del Reale Istituto d'Incorraggiamento alle Scienze Naturali*. Parts 1–5. [1843 (separate), part 1, 7:143–216, plate (Figs. 1–12) (Centuria prima, journal 1847); 1847 (separate), parts 2–3, 7:239–279, plates 1–2, 7:365–405, plates 3–4 (Centuria secunda, journal 1847); 1853 (separate), part 4, 8:225–299 (Centuria tertia et quartoe, journal 1855); 1862 (separate) part 5, 10:329–367 (journal 1863).] See Kerzhner (1983, *Mitt. Zool. Mus. Berlin*, 59:191) for documentation of dates.
- Fieber, F. X. 1837. *Beiträge zur Kenntniss der Schnabelkerfen (Rhynchota)*. *Beiträge zur gesamten natur-und Heilwissenschaft (Von Weilenweber)*. Prague. 1:97–111, 337–355.
- Fieber, F. X. 1860–1861. *Die europäischen Hemiptera. Halbflügler (Rhynchota Heteroptera)*. *Nach der analytischen Methode bearbeitet*. Gerold, Wien. 1860, i–vi, 1–112; 1861, 113–444, 2 plates.
- Henry, T. J. 1997. Phylogenetic analysis of the family groups within the infraorder Pentatomomorpha (Hemiptera: Heteroptera), with emphasis on the Lygaeoidea. *Ann. Entomol. Soc. Am.* 90:275–301.
- Herrich-Schaeffer, G. A. W. 1835. *Nomenclator entomologicus*. *Verzeichniss der europäischen Insecten; zur Erleichterung des Tauschverkehrs mit Preisen versehen*. I. Lepidoptera und Hemiptera. Friedrich Pustet, Regensburg [Hemiptera 1:35–116].
- Kiritshenko, A. N. 1951. True bugs of the European part of the USSR (Hemiptera): Key and bibliography. *Opredeliteli po Faune SSSR* 42:1–423 [In Russian].
- Lethierry, L. F. and G. Severin. 1893–1896. *Catalogue Général des Hémiptères*. R. Friedlander and Fils, Bruxelles and Berlin. [Pentatomidae, 1893, 1:i–x, 1–286; Coreidae, Berytidae, Lygaeidae, Pyrrhocoridae, 1894, 2:1–277, i–iii; Tingidae, Phymatidae, Aradidae, Hebridae, Hydrometridae, Henicocephalidae, Saldidae, Aepophilidae, Ceratocombidae, Cimicidae, Anthocoridae, 1896, 3:1–275].
- Lindberg, H. 1953. *Hemiptera Insularum Canariensium* (Systematik, Ökologie und Verbreitung der Kanarischen Heteropteren und Cicadinen. *Commentationes Biologicae* 14(1):1–304.
- Puton, A. 1869. *Catalogue des Hémiptères Hétéroptères d'Europe*. Deyrolle, Paris. i–vii + 42 pp.
- Puton, A. 1874. Notes pour servir à l'étude des Hémiptères. *Ann. Soc. Entomol. France* 5:213–234.
- Puton, A. 1875. *Catalogue des Hémiptères (Hétéroptères, Cicadines & Psyllides) d'Europe et du bassin de la Méditerranée*. 2nd edition. Deyrolle, Paris. 87 pp.

- Rossi, P. 1790. Fauna etrusca sistens insecta quae in provinciis Florentina & Pisana praesertim collegit Parus Rossius in Regio pisano Athenaeo. Typis Thomae Mosi & Sociorum Praesidium Facultate, Liburni. 2:1-348.
- Slater, J. A. 1964. A catalogue of the Lygaeidae of the world. 2 volumes. University of Connecticut, Storrs. 1688 pp.
- Southwood, T. R. E. and D. Leston. 1959. Land and water bugs of the British Isles. Frederick Warne and Co., London. 436 pp.
- Wagner, E. 1961. Zur Systematik der Gattung *Rhyparochromus* Hahn, 1826. Dtsch. Entomol. Z. 8(I/II):73-116.
- Wheeler, A. G., Jr. 1989. *Megalonotus sabulicola* (Heteroptera: Lygaeidae), an immigrant seed predator of *Centaurea* spp. (Asteraceae): distribution and habits in eastern North America. Proc. Entomol. Soc. Wash. 91:538-544.

THE GENUS *EMPEDOCLES* STÅL AND DESCRIPTION OF ONE NEW SPECIES (HEMIPTERA: COREIDAE: COREINAE: ACANTHOCEPHALINI) FROM SOUTH AMERICA

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Abstract.—The genus *Empedocles* Stål is redescribed, and one new species collected in Brazil and Argentina is described; new distributional data for *E. tenuicornis* (Westwood) is included; dorsal view illustrations, and drawings of antennal segments, pronotum, hind leg, and male and female genitalia are provided.

Key words: Hemiptera, Coreidae, Acanthocephalini, *Empedocles*, new species, Neotropical.

Brailovsky (1984) pointed out the sexual dimorphism in the genus *Empedocles* Stål based on the development of the hind tibia, which is narrower in the males with the inner expansion weakly developed and strongly spined, and the outer expansion with only one shallow emargination (Figs. 5, 7). On the females the inner expansion is lanceolate and not spined, and the outer one is broader with two deep emarginations (Figs. 6, 8). In the same paper, he illustrated what was thought at the time to be *E. tenuicornis* (Westwood), the only species known and which was reported from Brazil without a precise locality.

Recently, three specimens (1♂, 2♀) deposited in ZMHB, were studied and compared against the female type of *E. tenuicornis* deposited in OXUM. It was found that they are conspecific. This series collected in Brazil was again compared with the eight specimens (5♂, 3♀) previously considered as *E. tenuicornis*, and it was found that they have clear differences. This requires the description of a second species for *Empedocles*, the redescription of the genus, and the correction of localities previously referring to *E. tenuicornis*, which actually correspond to the new species.

The genus is characterized by having the hind tibiae expanded, the posterior angles of connexival segments IV to VI spined, antennal segment I internally ridged, and the pronotal disc densely tuberculate, with the area behind the callar region bearing a strong row of spines or tubercles.

The following abbreviations are used in the text: Oxford University Museum, Hope Entomological Collections, Oxford, Great Britain (OXUM); Instituto de Biología, Universidad Nacional Autónoma de México (UNAM); Zoologisches Museum, Humboldt Universität, Berlin, Germany (ZMHB):

All measurements are in millimeters.

EMPEDOCLES STÅL

Empedocles Stål, 1867: 541.

Redescription. *Head.* Wider than long, subquadrate, not declivent, flat dorsally; tylus projecting beyond juga as strongly compressed plate, with apex extending upward

as a single and robust conical projection; juga not visible from above, not extending past antenniferous tubercles; antenniferous tubercles oblique, unarmed, closely appressed to tylus, and distance between them less than half width of one antenniferous; posttylar sulcus evident; antennae shorter than body; antennal segment I stouter than segments II to IV, longer than maximal length of head, with outer face cylindrical, and inner face longitudinally ridged; segments II and III cylindrical, and moderately slender, and segment IV fusiform; antennal segment IV the longest, segment II longer than III, and longer or subequal to I, and segment I longer than III or subequal; ocelli barely raised, close to eyes; preocellar pit subcircular, and deep; eyes spherical, protuberant; postocular tubercle not evident; bucculae uniformly rounded, short, elevated, not projecting beyond antenniferous tubercles; rostrum reaching posterior border of mesosternum; rostral segment I the longest, segment II longer than III, and III longer or subequal to IV; rostral segments III and IV taken together shorter or subequal in length to rostral segment II. *Thorax*. Pronotum wider than long, trapezoidal, declivous, with distinct collar; frontal angles blunt; anterolateral margins obliquely straight, tuberculate; humeral angles produced laterally into broad sharp spine turning backwards (Fig. 12) or sharply spined and almost pointed outwards (Fig. 13); posterolateral margins sinuate with external third tuberculate, and internal third smooth; posterior margin slightly concave; calli slightly depressed, impunctate, separated along midline by slightly longitudinal depression; area behind callar region and pronotal disc heavily tuberculate; prosternum with deep concavity; mesosternum and metasternum flat, nonsulcate; mesosternum anteriorly tuberculate between procoxae; metapleural supracoxal spine absent; anterior lobe of metathoracic peritreme nearly circular, posterior lobe small, rounded. *Legs*. Fore and middle femora slender, armed ventrally with two rows of robust spines; spines stronger and wider on anterior row; dorsal surface smooth; hind femora incrassate, much more so in males, armed ventrally with one row of strong, large, and robust spines, with dorsal and lateral surface densely tuberculate, and provided with strong, and shorter robust spines; fore and middle tibiae cylindrical, sulcate, unarmed; hind tibiae expanded, widely in females, more narrowly in males; inner expansion slightly expanded, and strongly spined in males; inner expansion lanceolate, and not spined in females; outer expansion in males narrow, with one shallow emargination; outer expansion in females width, with two deep emarginations (Figs. 5–8). *Scutellum*. Triangular, flat, longer than wide, with apex subacute or truncated; basal third transversely elevated. *Hemelytra*. Macropterous, extending beyond apex of abdomen; apical margin slightly sinuate; costal margin emarginate. *Abdomen*. Connexival segments elevated, with posterior angles of segments IV to VI slightly spined; abdominal spiracles closer to anterior edge, far from lateral edge. *Male genitalia*. Genital capsule with posteroventral edge straight (Fig. 15) or concave (Fig. 14). *Parameres*. Shank elongate, robust; external arm convex; internal arm elongate, with wide tooth at apex (Figs. 16–17). *Female genitalia*. Abdominal sternite VII with plica and fissura; gonocoxae I elongate anteroposteriorly, in caudal view close, in lateral view with external face entire, and obliquely sinuate; paratergite VIII large, triangular, with visible spiracle; paratergite IX quadrangular, longer than paratergite VIII. Spermatheca with distal bulb nearly circular, rounded; sclerotized duct markedly coiled (more than eight coils); distal flange indistinct; proximal flange distinct; proximal sclerotized chamber spherical, large; spermathecal duct membranous (Fig. 18).

Discussion. *Empedocles* Stål, like *Meluchopetalops* Breddin (1903) and *Stenometaopodus* Breddin (1903), has the hind tibiae expanded, antennal segment I internally ridged, and the posterior angles of connexival segments V and VI spined. In *Acanthocephala* Laporte (1832), the hind tibiae are expanded, both the posterior angles of connexival segments V and VI are unarmed, antennal segment I is not internally ridged, and the pronotum lacks the strong transverse rows of spines or tubercles below the callar region characteristic of *Empedocles*.

In *Meluchopetalops* the outer expansion of hind tibiae is lanceolate without emarginations, and the inner expansion in both sexes are slightly expanded, without emarginations (Fig. 11). In *Empedocles* the outer expansion in both sexes has one or two deep or shallow emarginations, and the inner expansion in males is slightly expanded, and strongly spined, and in females lanceolate, and not spined (Figs. 5–8). In *Stenometaopodus* the outer expansion in males is straight (Fig. 9), in females slightly expanded and shorter, with one emargination, and the inner expansion in both sexes is lanceolate, slightly expanded, and shorter (Fig. 10). The pronotal disc of *Empedocles* is densely tuberculate, on the other two genera densely punctate.

Type species. *Metapodius tenuicornis* Westwood, 1842: 16.

Empedocles tenuicornis (Westwood)

Figs. 1,3,5–6,13,15–16

Metapodius tenuicornis Westwood, 1842: 16.

Discussion. This species is easily recognized by having the humeral angles of pronotum produced laterally, not strongly broadened, and sharply pointing outward (Fig. 13); antennal segment IV yellow with the basal and apical third pale brown, and antennal segments II and III red brown with the basal third yellow (Fig. 3).

Distribution. First described by Westwood (1842) without any data just “habitat—?”. Blote (1938) recorded this species from Brazil without a definite locality.

Material examined. BRAZIL, **Bahia:** 1♂, 1♀, without data (ZMHB). BRAZIL: without data (UNAM).

Empedocles luridus, new species

Figs. 2,4,7–8,12,14,17–18

Description. *Male. Dorsal coloration.* Ground color dark orange hazel; head with yellow mediolongitudinal vitta, and laterally with narrow black stripe; ocellar tubercle bright red; antennal segment I with inner face reddish brown, and outer face orange hazel; antennal segments II and III reddish brown, and IV light yellow (Fig. 4); head and pronotum scattered with bright red diminutive spots; scutellum with apex, and two basal discoidal spots near to middle third yellow; connexival segments reddish brown, with anterior and posterior angle yellow; dorsal segments reddish brown with yellow mediolongitudinal stripe running from II to posterior margin of segment VI. *Ventral coloration.* Ground color dark orange hazel, with following areas black to dark reddish brown: anterior lobe of metathoracic peritreme, spines and tubercles of each leg, outer expansion of hind tibiae, hind coxae, hind trochanter, lateral margins of mesosternum, and abdominal spiracle; rostral segment I reddish brown, with posterior margin dirty yellow; segment II to IV dirty yellow, with apex

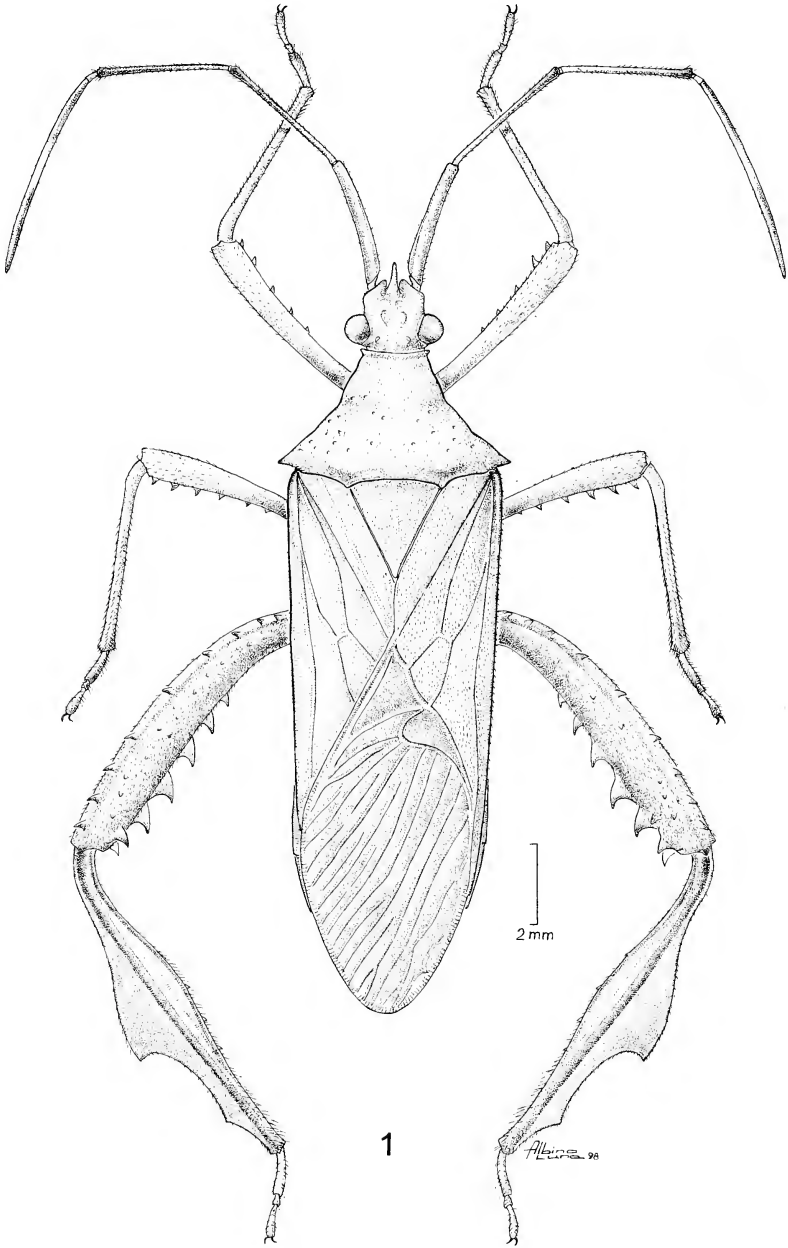


Fig. 1. *Empedocles tenuicornis* (Westwood), dorsal view. Male.

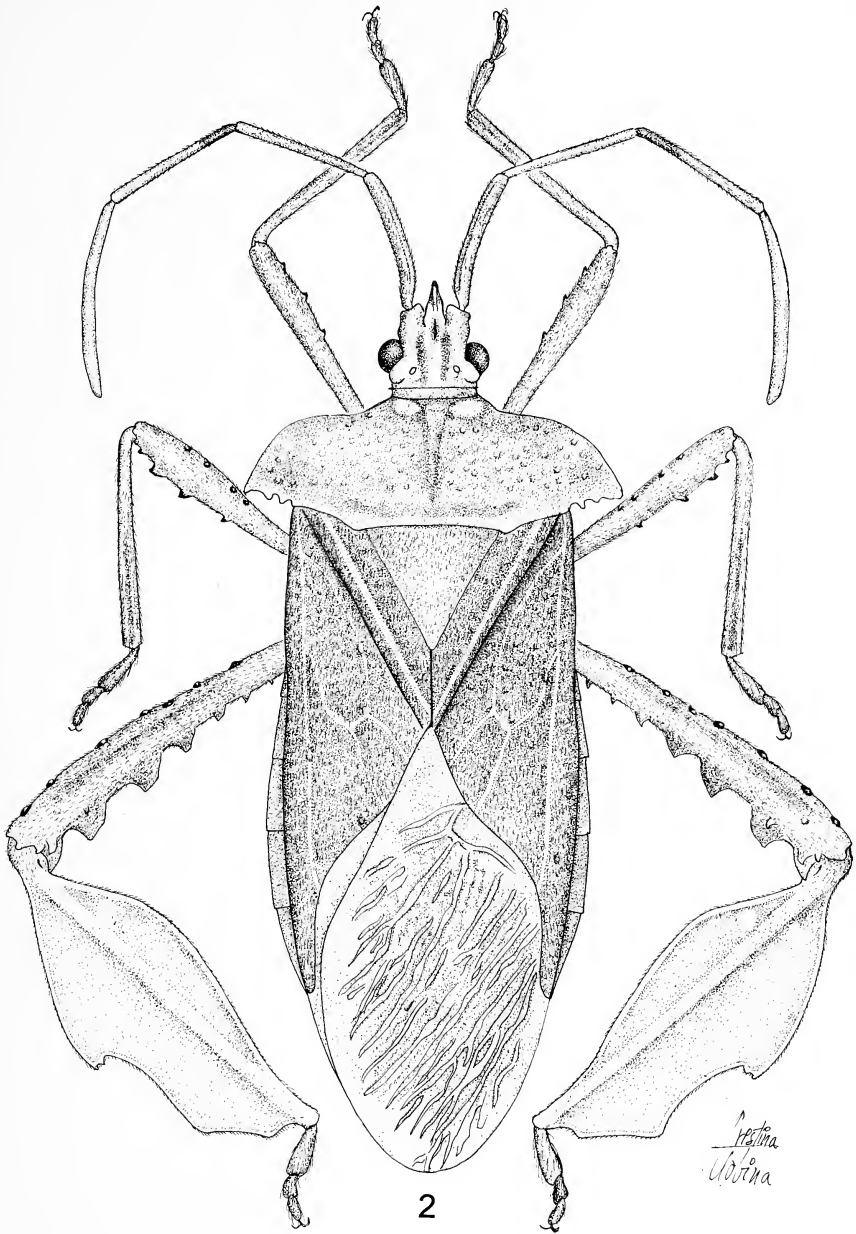
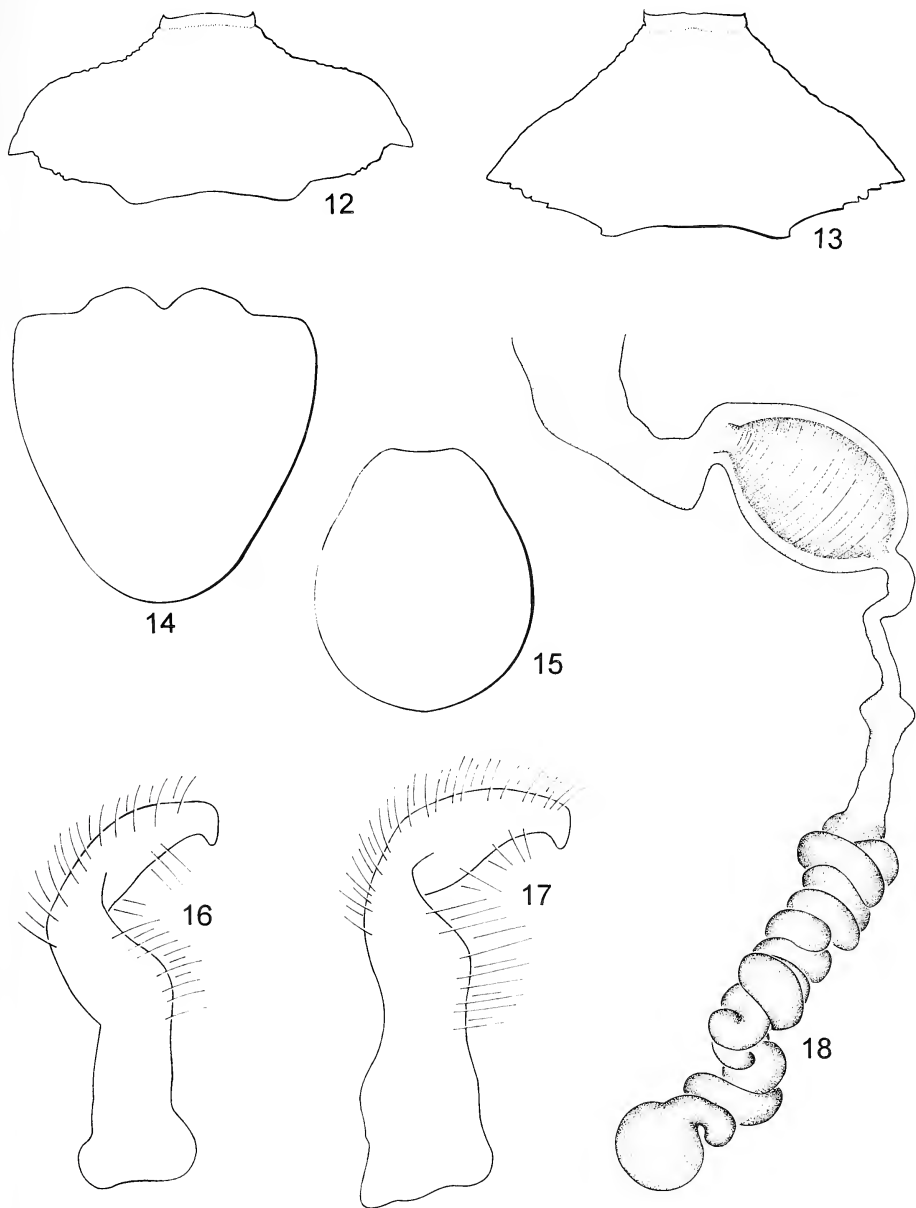


Fig. 2. *Empedocles luridus* new species, dorsal view. Female.



Figs. 3-4. Antennal segments of *Empedocles* spp. 3. *E. tenuicornis* (Westwood). 4. *E. luridus* new species. Figs. 5-8. Hind leg of *Empedocles* spp. 5-6. *E. tenuicornis* (Westwood). 5. Male. 6. Female. 7-8. *E. luridus* new species. 7. Male. 8. Female. Figs. 9-10. Hind leg of *Stenometaopodus impictus* Breddin. 9. Male. 10. Female. Fig. 11. Hind leg of *Meluchopetalops banausus* Breddin (male and female same shape of leg).



Figs. 12–13. Pronotum of *Empedocles* spp. 12. *E. luridus* new species. 13. *E. tenuicornis* (Westwood). Figs. 14–15. Caudal view of male genital capsule of *Empedocles* spp. 14. *E. luridus* new species. 15. *E. tenuicornis* (Westwood). Figs. 16–17. Parameres of *Empedocles* spp. 16. *E. tenuicornis* (Westwood). 17. *E. luridus* new species. Fig. 18. Spermatheca of *Empedocles luridus* new species.

of IV black. *Structure*. Humeral angles of pronotum produced laterally, broadened, with sharp apical spine turning backwards (Fig. 12). *Genital capsule*. Fig. 14. *Parameres*. Fig. 17.

Measurements. Length head: 2.20; width across eyes: 2.32; interocular space: 1.28; interocellar space: 0.72; length of antennal segments: I, 3.68; II, 4.20; III, 3.76; IV, 5.40; length of labial segments: I, 2.04; II, 1.68; III, 0.82; IV, 1.00. Pronotum length: 3.92; width across frontal angles: 1.86; width across humeral angles: 7.56. Scutellar length: 2.84; width: 2.72. Total body length: 19.90.

Female. Similar to male. Connexival segments VIII and IX, dorsal abdominal segments VIII and IX, and genital plates light to dark orange hazel, with or without black to dark brown reflections, or connexival segments VIII and IX, and dorsal abdominal segments VIII and IX black, and genital plates dark orange hazel; inner and outer expansions of hind tibiae black to reddish brown. *Spermatheca*. Fig. 18.

Measurements. Length head: 2.22; width across eyes: 2.32; interocular space: 1.28; interocellar space: 0.76; length of antennal segments: I, 3.28; II, 3.64; III, 3.28; IV, 4.80; length of labial segments: I, 2.16; II, 1.80; III, 0.84; IV, 1.00. Pronotum length: 4.16; width across frontal angles: 1.96; width across humeral angles: 8.08. Scutellar length: 2.96; width: 3.00. Total body length: 20.65.

Variation. 1, Head in ventral view black, with buccula dark orange hazel. 2, Pronotal disc black. 3, Middle coxae black to reddish brown. 4, Propleura, mesopleura, and metapleura with diffuse black coloration. 5, Abdominal sterna black, with dark orange hazel reflections.

Types. Holotype, ♂, BRAZIL, Santa Catarina, Nova Teutonia, 27°11'N, 52°23'W, 18.v.1967, F. Plaumann (UNAM). Paratypes: 4 ♂♂, 3 ♀♀, same data as holotype except 12.i.1960, 18.i.1963, xii.1967, iii.1975, i.1977, iii.1977 (UNAM). ARGENTINA, Misiones: 1 ♀, San Ignacio, x.1982, D. Carpintero (UNAM).

Discussion. The only other previously known species, *E. tenuicornis* (Westwood), is characterized by having the humeral angles of pronotum produced laterally, relatively slender, sharply spined pointed outward (Fig. 13), with antennal segment IV yellow with basal and apical third light brown, and antennal segments II and III reddish brown with basal third yellow (Fig. 3). *E. luridus* new species, has the humeral angles produced laterally, broadened, with broad sharp spine turning backwards (Fig. 12), with antennal segment IV entirely light yellow, and antennal segments II and III reddish brown (Fig. 4).

Etymology. Named for the light coloration of antennal segment IV; from the Latin, *luridus*, pale yellow.

Distribution. Known only from Brazil and Argentina.

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LITERATURE CITED

Blote, H. C. 1938. Catalogue of the Coreidae in the Rijksmuseum van Natuurlijke Histoire. Part IV. Coreinae. Third Part. Zool. Meded. 20:275-308.

- Brailovsky, H. 1984. Una nueva especie del Género *Stenometapodus* Breddin y algunas notas acerca de *Empedocles tenuicornis* (Westwood) (Hemiptera-Heteroptera-Coreidae-Acanthocephalini). An. Inst. Biol. Univ. Nal. Autón. México 54 (1983), Ser. Zool. (1):63-68.
- Breddin, G. 1903. Beitrage zur Hemipteren fauna der Anden. Sonder-Abdruck Sitz. Berich. Gesell. Natur-forsch. 8:366-383.
- Laporte, F. L. De. 1832. Essai d'une classification systématique de l'ordre des Hemiptères (Hemiptères Hétéroptères, Latr.) Family Anisoscélites, Lygéites, and Coréites. Mag. Zool. France 52:24-47.
- Stål, C. 1867. Bidrag till Hemipterernas Systematik. Ofv. Kongl. Vetensk-Akad. Forh. 7:491-560.
- Westwood, J. O. 1842. Catalogue of Hemiptera in the collection of the Rev. F. W. Hope, M. A., with short latin descriptions of the new species. Part II. Printed by J. C. Bridgewater. Oxford Street:1-26.

**REVIEW OF THE SCYDMAENIDAE (COLEOPTERA) OF
EASTERN ASIA, WITH PARTICULAR REFERENCE TO
SCYDMAENUS, AND DESCRIPTION OF THE FIRST
SCYDMAENID FROM HAINAN ISLAND, CHINA**

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Abstract.—The discovery of a new species of Scydmaenidae (Coleoptera) from Hainan Island, People's Republic of China (hereafter as China), prompted this review of the East Asian Scydmaenidae. *Scydmaenus hainanensis* O'Keefe, n. sp., from Mt. Wu-Zhi-Shan, is the first species of Scydmaenidae described from Hainan Island and the seventh species of *Scydmaenus* Latreille described from China. Illustrations of the habitus, antenna, and male genitalia for *S. hainanensis*, a discussion of its relationship to other *Scydmaenus*, and a key to the *Scydmaenus* of China are included. A catalog of the species of eastern Asia and a discussion of their relationships to the scydmaenid fauna of other regions are presented.

The family Scydmaenidae (Coleoptera: Staphylinoidea) of eastern Asia has received relatively little attention. Only 97 species of Scydmaenidae have been described from eastern Asia (eastern Russia, Korea, China, Japan, and Taiwan) (see catalog below). These are considerably fewer species, considering the area covered, than are known from either the Nearctic (some 230 species) or the western Palearctic (over 300 species), and is in sharp contrast to southeast Asia and Indonesia where the number of known species is nearly 400. Before 1915, only 27 species were known from eastern Asia: 5 from eastern Russia (Reitter 1896), 6 from Taiwan (Reitter 1914), and 16 from Japan (Reitter 1891; Sharp 1874, 1886). Since 1962, 68 new species have been described from this region. Many of these were described from Taiwan (22) (Franz 1985), eastern Russia (22) (Kurbatov 1988, 1990a, 1990b, 1991, 1993a, 1993b, 1995), or Japan (13) (Franz 1976a; Hisamatsu 1985; Kurbatov 1995; Nakane 1963; Sawada 1962). Only 9 species have been described from China (Franz 1968, 1985, 1988) and one from Korea (Franz 1995).

To date, only three genera of Scydmaenidae are known from China (*Euconnus* Thomson, *Horaemorphus* Franz, and *Scydmaenus* Latreille) and at least two others (*Eutheia* Stephens and *Stenichnus* Thomson), found on Taiwan, are likely to occur in China. A series of *Scydmaenus* (collected by LJK) were collected from Hainan Island, China. These represent the first scydmaenids known from Hainan Island and the tenth species known from China. In this paper, the senior author (STO) describes this new species, and we present a review of the eastern Asian Scydmaenidae.

A key to the known species of *Scydmaenus* of China is provided below. Undoubtedly, this key will need to be expanded and modified as additional species are discovered. Franz (1983: 180–182) provided a key to the species of *Scydmaenus* of Singapore, Malakka, Thailand, and Vietnam. There are no keys to the 17 species of

Scydmaenus from Taiwan, Japan, or Russia and it is beyond the scope of this project to provide one at this time.

KEY TO THE SPECIES OF *SCYDMAENUS* OF CHINA

1. Posterior margin of pronotum with 2 foveae 2
 - Posterior margin of pronotum with 4 foveae 4
2. 1.80–2.00 mm in length 3
 - 2.50–2.90 mm in length *S. kunmingensis* Franz
3. Antennae longer than head and pronotum combined; each elytron with basal impression; apex of aedeagus narrowed, elongate (Franz 1988:24, fig. 1a); Yunnan and Sichuan Provinces *S. chinensis* Franz
 - Antennae shorter than head and pronotum combined; elytra without basal impression; apex of aedeagus broad, emarginate (Franz 1985:118, fig. 28); Fujian Province *S. kiatusensis* Franz
4. Antennae shorter than head and pronotum combined; Fujian or Hainan Provinces 5
 - Antennae as long as or longer than head and pronotum combined; Sichuan Province 6
5. Apex of aedeagus tapered, unmodified (Franz 1985:115, fig. 27); elytra with a basal impression; Fujian Province *S. fukiensis* Franz
 - Apex of aedeagus broad, emarginate (Fig. 3b); elytra without basal impression; Hainan Province *S. hainanensis* O'Keefe n. sp.
6. Antennomere VIII wider than long; antennomere I 2.5 times longer than wide; apex of aedeagus simple, unmodified (Franz 1968:538, fig. 2) *S. szechuanensis* Franz
 - Antennomere VIII as long as wide; antennomere I 2 times longer than wide; apex of aedeagus modified into dorsal and ventral directed points (Franz 1968:537, fig. 1) *S. sinensis* Franz

***Scydmaenus* (s. str.) *hainanensis* O'Keefe new species**

Figs. 1–3.

Types. Holotype: male: CHINA, Hainan Island, Mt. Wu-Zhi-Shan, 800–1,500 m, 23-29-III-1998, Li Jing Ke coll. (Field Museum of Natural History, Chicago, IL). Paratypes: 3 ♂♂ 1 ♀, same data as holotype. Paratypes deposited in collections of authors and Field Museum of Natural History.

Diagnosis. *Scydmaenus hainanensis* is typical for *Scydmaenus* (s. str.) (Fig. 1)—pygidium exposed, nearly vertical; antennal club distinct, compact, composed of distal 3 antennomeres with short, dense vestiture; antennomere I with distal notch; antennomeres III–VII slightly longer than wide, V longer than either IV or VI; metacoxae distinctly separated. *Scydmaenus hainanensis* can be separated from many *Scydmaenus* by its moderate body size (2.67–2.90 mm) and presence of four distinct pits along the posterior margin of the pronotum. Examination of the aedeagus (Fig. 3) is needed to confirm species identification.

Description. Males 2.80–2.85 mm long, female 2.67 mm long; dark reddish-brown in color throughout; vestiture relatively short and thin on head and pronotum, long and thicker on elytra.

Head. Head 0.56–0.59 mm long (males), 0.56 mm long (female), 0.48–0.50 mm wide at eyes (males), 0.48 mm wide at eyes (female); vertex distinctly wider than long, moderately convexly rounded, without sculpturing; posterior of head transverse between vertex and occiput; occiput three-fourths width of head; eyes large, flat, ovoid, anterior; antennae (Fig. 2) shorter than head and pronotum combined; anten-

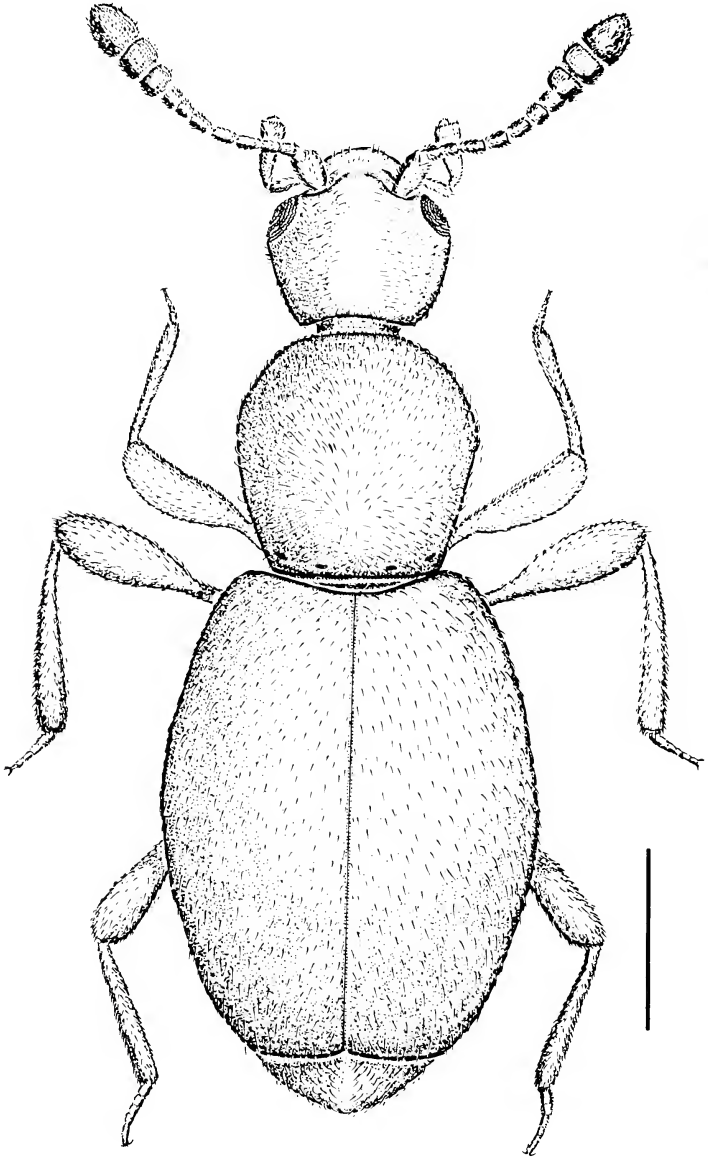


Fig. 1. *Scydmaenus hainanensis* O'Keefe n. sp., dorsal view. Scale bar = 0.50 mm.

nomere I 1.5 times longer than wide; antennomeres II–V subcylindrical; antennomeres II–IV subequal in size and shape, slightly longer than wide; antennomere V nearly twice as long as wide, 1.5 times longer than IV; antennomere VI subtrapezoidal, widest at distal end, as long as wide, half as long as V; antennomeres VII–VIII rectangular, slightly wider than long, subequal in size and shape to each other,

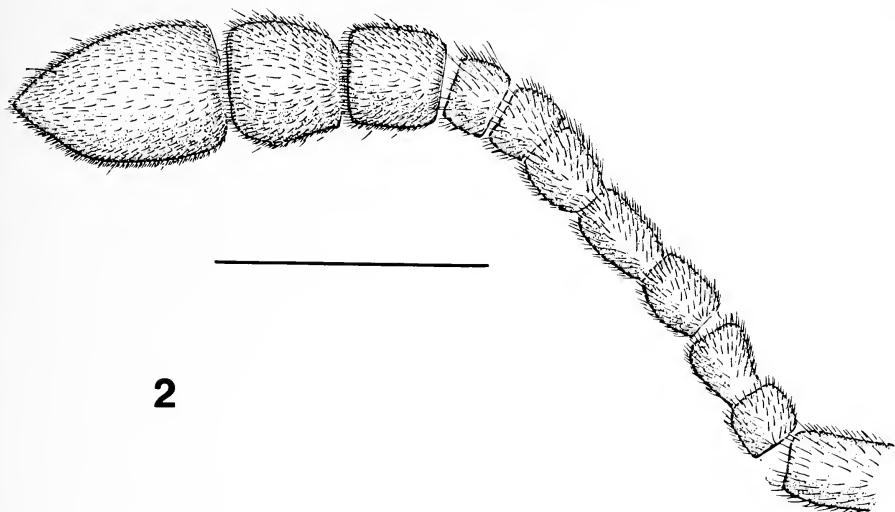


Fig. 2. *Scydmaenus hainanensis* O'Keefe n. sp., right antenna, lateral view. Scale bar = 0.25 mm.

each shorter and slightly wider than VI; antennomeres IX–XI forming distinct, compact club, slightly lighter in color than preceding antennomeres; antennomeres IX–X subtrapezoidal, widest at distal end; antennomere XI obovoid, apex gradually tapered, as long as IX and X combined; vestiture thin, suberect.

Pronotum. Pronotum slightly longer than broad, 0.74–0.75 mm long (males), 0.67 mm long (female), 0.64–0.66 mm wide at widest point (males), 0.64 mm wide at widest point (female), 0.43–0.46 mm wide at base (males), 0.45 mm wide at base (female); widest at anterior third; anterior angles gradually rounded, evenly tapered posteriorly; slightly convex; with 4 distinct pits along posterior margin, without posterolateral carinae; vestiture thin, dense, suberect.

Elytra. Elytra 1.49–1.54 mm long (males), 1.44 mm long (female), 0.96–0.98 mm wide (males), 0.96 mm wide (female); elytral silhouette ovoid, 1.7 times longer than wide, slightly convex, without basal foveae or grooves; humeri weakly developed, but present; scutellum small, but visible; vestiture golden, dense, long, suberect; pygidium exposed, subtriangular, nearly vertical. Hindwings, at least in males, complete.

Legs. Legs moderate in length, relatively stout (as in Fig. 1); male protarsomere I distinctly widened; femora and tibiae without modifications.

Venter. Prosternum flat, one-third prothoracic length, vestiture short, dense; mesosternum longitudinally carinate between coxae; metasternum large, slightly convex, vestiture short, moderately dense; metacoxae separated by coxal width; abdominal sternites convex, unmodified, visible sternite 1 nearly as long as 2–3 combined, sternites 2–5 subequal in length, sternite 4 nearly as long as 3–5 combined.

Male genitalia (Fig. 3a–c). Aedeagus elongate, nearly parallel-sided, slightly curved dorsally, darkly sclerotized; median lobe encased by fused parameres, shorter

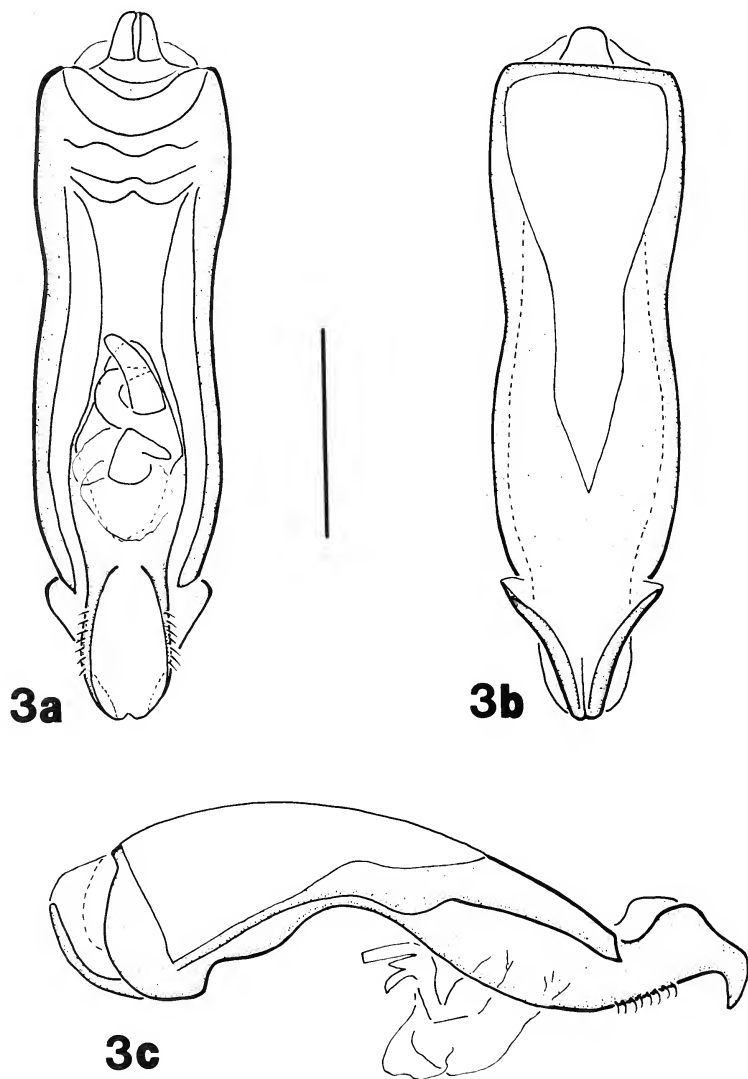


Fig. 3. *Scydmaenus hainanensis* O'Keefe n. sp., aedeagus, 3a. dorsal view, 3b. ventral view, 3c. right lateral view. Scale bar = 0.25 mm.

than parameres, three-fourths aedeagal length; ventral surface convex, thinly sclerotized; base with transverse, thickened cuticular band distal to membranous region and median longitudinal sclerotized section; parameres nearly inconspicuous at base, fused to median lobe at apex; apex highly modified into dorsal trough and arrow-head-shaped ventral projection; distal lateral margins carinate; distal dorsal margin of parameres with row of short setae.

Etymology. The name was derived from Hainan Island, China, the type locality.

Comments. *Scydmaenus hainanensis* is most easily separated from other species of *Scydmaenus* by the form of the aedeagus. In none of the other six known species of *Scydmaenus* from China is the apex modified into an arrowhead-shaped ventral projection (Fig. 3a, b). The aedeagus of *S. chinensis* Franz (Franz 1988:24, fig. 1a) has a much more elongate and narrow apex. For *S. kunmingensis* Franz, Franz (1988:25) stated that the aedeagus was similar to that of *S. minangkabauensis* Blattný (Blattný 1925:3) which he illustrated (Franz 1989:39, fig. 7) as being considerably more curved dorsally and narrowed apically. The aedeagus of *S. szechuanensis* Franz (Franz 1968:538, fig. 2) is strongly tapered at the apex and less curved dorsally. The aedeagus of *S. sinensis* Franz (Franz 1968:538, fig. 1) is modified at the apex, however, the apex has both dorsally and ventrally elongate projections. The aedeagus of *S. fukiensis* Franz (Franz 1985:115, fig. 27) is much broader at the base and has an unmodified apex. The aedeagus of *S. kiautunensis* Franz (Franz 1985:118, fig. 28) has a broadly bilobed apex, is more elongate, and lacks the modified apex of *S. hainanensis*. Of the three species from Taiwan for which there are figures (*S. vestitoides* Reitter, *S. csikii* Franz, and *S. taiwanicus* Franz) (Franz 1985), none have the aedeagal apex modified as it is in *S. hainanensis*. I have examined Franz' illustrations of other *Scydmaenus* from Thailand and Vietnam (Franz 1983, 1985, 1989) and only *S. vietnamensis* Franz (Franz 1983:179, fig. 6) possibly has a similarly modified aedeagal apex (at least from the lateral perspective). However, Franz stated *S. vietnamensis* males lack widened protarsi, have smaller eyes, and lack foveae on the pronotum. The protarsi of male *S. hainanensis* are distinctly widened, the eyes are large, and the pronotum has four distinct foveae. I have examined figures of *Scydmaenus* aedeagi in nearly all of Franz' articles (for a complete listing of Franz' publications see O'Keefe 1998) and have found aedeagi with similarly modified apices (only similar from the lateral perspective and none similar from the dorsal perspective) only from Africa. These species include *S. gabonensis* Lhoste (Franz 1961:167, fig. 8), *S. pseudotschadensis* Franz (Franz 1962:1032, fig. 2), *S. saharae* Franz (Franz 1962:1033, fig. 3), *S. sudanensis* Franz (Franz 1971a:9, fig. 1), *S. rhodesiae* Franz (Franz 1979:97, fig. 105), *S. newellianus* Franz (Franz 1979:98, fig. 106), *S. vanboveri* Franz (Franz 1976b:971, fig. 1), *S. makensis* Franz (Franz 1976b:973, fig. 2), *S. efflorescens* Schaufuss (Franz 1982:29, fig. 19), *S. schaufussi* Reitter (Franz 1982:21, fig. 10), and *S. moheliensis* Franz (Franz 1986:315, fig. 283). None of the *Scydmaenus* from the Neotropics, southeast Asia, or Australia/New Zealand that have published illustrations of the aedeagus have the genitalia modified as is found in *S. hainanensis*.

Measurements were made using a calibrated ocular micrometer on a Zeiss stereo microscope at 63X. Length measurements were from a lateral perspective as follows: head length—distance from posterior of vertex to apex of clypeus; pronotal length—distance from dorsoposterior margin of pronotum to anterior margin of pronotum at point of head insertion; and elytral length—distance from apex of elytron to anterior margin of humeral angle. Width measurements were from a dorsal perspective as follows: head width—distance across eyes; maximum pronotal width—distance across widest part of pronotum; pronotal basal width—distance between posterior-lateral angles of pronotum; and elytral width—distance across elytra at the widest point. Body length was the sum of head length, pronotal length, and elytral length.

DISCUSSION

The family Scydmaenidae is currently divided into eleven tribes (Newton and Franz 1998). Only four of these are known to occur in eastern Asia: Eutheini, Cephenniini, Cyrtoscydmini, and Scydmaenini. Of the remaining seven tribes, three (Leptoscydmini, Plaumanniolini, and Siamitini) are each known from a single genus with one or two described species, and the other four (Clidicini, Mastigini, Leptomastacini, and Chevrolatiini) are widely distributed, but are not known to occur in eastern Asia. The Eutheini and Cephenniini are both hypothesized to be basal lineages within the Scydmaenidae (Hansen 1997, Newton and Franz 1998) and are both well represented in eastern Asia. The classification and species numbers discussed below were taken from Newton and Franz (1998).

Eutheini. The Eutheini are Holarctic in distribution and include five genera, three of which (*Eutheia* Stephens, *Euthiconus* Reitter, and *Veraphis* Casey) are found in eastern Asia. About one quarter of the known species of each genus occur in eastern Asia. The distribution of *Eutheia* and *Euthiconus* also includes western Europe and eastern North America and the distribution of *Veraphis* also includes western North America.

Cephenniini. The Cephenniini are nearly world wide in distribution with various genera being either from northern latitudes or from more equatorial or southern latitudes. Of the ten genera, three (*Chelonoidum* Strand, *Cephennodes* Reitter, and *Paraneseuthia* Franz) occur in eastern Asia. *Chelonoidum* have nearly a Holarctic distribution, occurring not only in eastern Asia, but also in Europe and North America. In addition to being found in eastern Asia, *Cephennodes* also occur in the Oriental Region and Africa, and *Paraneseuthia* are also known from Fiji.

Scydmaenini. The Scydmaenini include seven genera, only one of which, *Scydmaenus*, occurs in eastern Asia. This genus is found world wide and includes 31 described subgenera and numerous species placed as *incertae sedis*. Of the 730 described species, 24 are known from eastern Asia. This group is undoubtedly paraphyletic, and, without further analysis and recognition of smaller monophyletic groups, any biogeographic hypotheses or conclusions are tentative. However, three of the subgenera, *Mascarensia* Franz, *Eustemmus* Reitter, and *Nepaloscydmaenus* Franz, possibly do represent smaller monophyletic groups and can be used here for discussion. *Mascarensia* are widespread throughout the Oriental and Australian Regions and are also found on Madagascar. *Eustemmus* also occur in the western Palearctic and Ethiopian Regions and on New Caledonia. *Nepaloscydmaenus*, in addition to eastern Asia, also occur in Nepal.

Cyrtoscydmini. The Cyrtoscydmini include 46 recognized genera, of which five (*Euconus* Thomson, *Horaeomorphus* Schaufuss, *Microscydmus* Saulcy & Croissandeau, *Neuraphes* Thomson, and *Stenichnus* Thomson) occur in eastern Asia. All of these genera are poorly represented in eastern Asia, with perhaps less than 5% of the known species being from this region. *Euconus* with 37 subgenera and nearly 2,500 described species, is most likely paraphyletic and of little current use for biogeographic study. However, six of the subgenera are known from eastern Asia (*Cladoconus* Reitter, *Euconophron* Reitter, *Himaloconus* Franz, *Napochus* Thomson, *Psomophus* Casey, and *Pycnophus* Casey), and four of these are biogeographically useful. *Psomophus* and *Napochus* are world wide in distribution, and *Napochus*

is possibly polyphyletic. In addition to eastern Asia, *Cladoconnus* and *Euconophron* are also found in the western Palearctic and Africa; *Himaloconnus* are also found in Nepal, and *Pycnophus* are circumtropical and Nearctic. Of the remaining four cyrtoscydmine genera, both *Microscydmus* and *Stenichnus* occur world wide, *Horaemorphus* are also found on Madagascar, Australia, and the Oriental Region, and *Neuraphes* also occur in the western Palearctic and Nepal.

In summary, the scydmaenid fauna of eastern Asia has some components shared with those of the western Palearctic and southeast Asia, and has some components that are either Holarctic or nearly world wide. Of the taxa found in eastern Asia, six (*Euconnus*, *Microscydmus*, *Pycnophus*, *Psomophus*, *Scydmaenus*, and *Stenichnus*) are nearly worldwide in distribution and four others (*Chelonoidum*, *Eutheia*, *Euthiconus*, and *Veraphis*) are Holarctic in distribution. With the western Palearctic, eastern Asia also shares *Cladoconnus*, *Euconophron*, *Neuraphes*, *Pararaphes*, and *Scydmorephes*; and with southeast Asia, eastern Asia shares *Cephennodes*. In addition to eastern Asia, *Horaemorphus* and *Mascarensia* are also found in Madagascar, southeast Asia and Australia, *Himaloconnus* and *Nepaloscydmaenus* also occur in India, and *Paraneseuthia* are also known from Fiji. Two scydmaenid lineages, Chevroletiini and Mastiginae, are absent from eastern Asia. The Eutheiiini and Cephenniini are proportionately better represented than either the Cyrtoscydmini or Scydmaenini, possibly due in large part to the recent efforts of Kurbatov (Kurbatov 1990a, 1991, 1995). If the scydmaenid fauna of eastern Asia is similar in numbers of species to that of either Europe or North America, then a doubling or tripling of the number of species should be expected.

CATALOG OF THE SCYDMAENIDAE OF EASTERN ASIA

The following is a catalog of the Scydmaenidae of eastern Asia (eastern Russia, Korea, Japan, China, and Taiwan). Genera are arranged alphabetically within each tribe and species arranged alphabetically within each genus. Valid names are in **bold italics**; original combinations, if different from valid names, are in *italics* following valid names; and junior synonyms are in **bold**. The catalog of species from eastern Asia is included here because of the significant number of species described from this region since the previous catalog (Csiki 1919), and is broader in scope than the catalog provided by Franz (Franz 1976a:58–60) for the Japanese species.

EUTHEIINI

- Eutheia exortiva* Kurbatov 1990a:137, figs. 1g–h; Kurbatov 1990b:80, figs. 1g–h.
RUSSIA (Primorski)
- Eutheia hariola* Kurbatov 1991:153, fig. a.
RUSSIA (Primorski)
- Eutheia holzeri* Franz 1976a:51, 58, fig. 1.
JAPAN
- Eutheia japonica* Sawada 1962:20, figs. 6–7; Franz 1976a:58.
JAPAN
- Eutheia klapperichi* Franz 1985:93, fig. 3.
TAIWAN
- Eutheia simillima* Franz 1985:93, fig. 2.
TAIWAN
- Eutheia taiwanensis* Franz 1985:92, fig. 1.
TAIWAN
- Euthiconus lustrifucus* Kurbatov 1990a:136, figs. 1a–c, 1d–f; Kurbatov 1990b:79, figs. 1a–c, 1d–f.
RUSSIA (Primorski, Kurile Islands)
- Euthiconus paradoxus* Sawada 1962:19, figs. 1–5; Franz 1976a:58.
JAPAN

- Veraphis fatiloquus* Kurbatov 1995:944, figs. 1–4. RUSSIA (Primorski)
Veraphis irkutensis (Reitter); Franz 1971b:76; Kurbatov 1990a:139; Kurbatov 1990b:83; Kurbatov 1995:946. RUSSIA (Irkutsk, Primorski)
Euthia irkutensis Reitter 1896:64; Csiki 1919:5.
Euthia euplecticornis Reitter 1896:64; Csiki 1919:4. Synonymized by Franz 1971b:76.
Veraphis ishikawai Hisamatsu 1985:13, figs. 15–16; Kurbatov 1995:946. JAPAN

CEPHENNIINI

- Cephennodes japonicus* (Sharp); Csiki 1919:17; Kurbatov 1995:948, fig. 7. JAPAN
Cephennium japonicum Sharp 1886:50; Franz 1976a:58.
Cephennodes vafer Kurbatov 1995:946, figs. 5–6. RUSSIA (Kurile Islands)
Chelonoidum besucheti Kurbatov 1995:954, figs. 16–17. JAPAN
Chelonoidum graeseri (Reitter); Kurbatov 1995:948, figs. 8–9. RUSSIA (Primorski)
Cephennodes graeseri Reitter 1887:270; Csiki 1919:17.
Chelonoidum loebli Kurbatov 1995:954, figs. 18–19. JAPAN
Chelonoidum moderatum Kurbatov 1995:951, figs. 12–13. RUSSIA (Primorski, Kurile Islands), JAPAN
Chelonoidum torsum Kurbatov 1995:957, figs. 20–21. JAPAN
Chelonoidum ussuricum Kurbatov 1995:952, figs. 14–15. RUSSIA (Primorski)
Chelonoidum pullatum Kurbatov 1995:948, figs. 10–11. RUSSIA (Kurile Islands), JAPAN
Paraneseuthia saga Kurbatov 1991:154, fig. b. RUSSIA (Kurile Islands)
Paraneseuthia trepida Kurbatov 1990a:137, figs. 1j, 1l–m; Kurbatov 1990b:82, figs. 1j, 1l–m. RUSSIA (Primorski)

CYRTOSCYDMINI

- Euconnus aculeifer* Franz 1985:103, fig. 14. TAIWAN
Euconnus (Himaloconnus) alishanensis Franz 1985:96, fig. 6. TAIWAN
Euconnus alishanicus Franz 1985:100, fig. 11. TAIWAN
Euconnus alishaniformis Franz 1985:101. TAIWAN
Euconnus (Psomophus) chinensis Franz. CHINA (Fujian)
Euconnus (Spanioconnus) chinensis Franz 1985:114, fig. 25.
Euconnus (Napochus) deprecator Kurbatov 1993b:595, figs. 5–7. RUSSIA (Primorski)
Euconnus dulcis Sharp 1886:47; Csiki 1919:47; Franz 1976a:59. JAPAN
Euconnus efferus Franz 1985:104, fig. 15. TAIWAN
Euconnus fenchihuensis Franz 1985:106, fig. 17. TAIWAN
Euconnus fenchihui Franz 1985:105, fig. 16. TAIWAN
Euconnus formosanus Reitter 1914:266; Franz 1985:108, fig. 20. TAIWAN
Euconnus (Microscydmus) formosanus Reitter; Csiki 1919:55.
Euconnus fukiensis Franz 1985:115, fig. 26. CHINA (Fujian)
Euconnus (Euconophron) fustiger (Sharp); Franz 1976a:55, 59, fig. 4. JAPAN
Scydmaenus fustiger Sharp 1874:128.
Euconnus fustiger (Sharp); Sharp 1886:47; Csiki 1919:47.

- Euconnus impar* Sharp 1886:46; Csiki 1919:49; Franz 1976a:59. JAPAN
Euconnus japonicus (Sharp); Sharp 1886:47; Csiki 1919:49; Franz 1976a:59. JAPAN
Scydmaenus japonicus Sharp 1874:127.
Euconnus (Himaloconnus) klapperichianus Franz 1985:97, fig. 7. TAIWAN
Euconnus lewisii Sharp 1886:47; Csiki 1919:50; Franz 1976a:59. JAPAN
Euconnus lijingkei Franz 1995:36, fig. 1. KOREA
Euconnus microalishanicus Franz 1985:103, fig. 13. TAIWAN
Euconnus (Euconophron) miyawakainus Franz 1976a:56, 59, fig. 5. JAPAN
Euconnus oscillans Sharp 1886:48; Csiki 1919:50; Franz 1976a:59. JAPAN
Euconnus paraalishanicus Franz 1985:102, fig. 12. TAIWAN
Euconnus (Napochus) parafricatoris Franz 1985:99, fig. 9. TAIWAN
Euconnus raucus Sharp 1886:48; Csiki 1919:51; Franz 1976a:59. JAPAN
Euconnus (Napochus) sauteri Reitter 1914:265; Csiki 1919:62; Franz 1985:97, fig. 8. TAIWAN
Euconnus sauterianus Franz 1985:106, fig. 18. TAIWAN
Euconnus (Napochus) schenklingi Reitter 1914:266; Csiki 1919:63; Franz 1985:99. TAIWAN
Euconnus schonfeldti Reitter 1891:19; Csiki 1919:51; Franz 1976a:59. JAPAN
Euconnus (Pycnophus) taiwanicus Franz. TAIWAN
Euconnus (Nudatoconnus) taiwanicus Franz 1985:99, fig. 10.
Euconnus taiwanus Franz 1985:107, fig. 19. TAIWAN
Euconnus (Cladoconnus) ussuriensis Kurbatov 1988:1744, figs. d-f. RUSSIA (Primorski)
Horaeomorphus (s.str.) chinensis Franz 1985:116. CHINA (Fujian)
Horaeomorphus (s.str.) taiwanensis Franz 1985:95. TAIWAN
Microscydmus akauensis Reitter 1914:267; Franz 1985:109. TAIWAN
Euconnus (Microscydmus) akauensis (Reitter); Csiki 1919:55.
Microscydmus debilis (Sharp): NEW COMBINATION JAPAN
Scydmaenus debilis Sharp 1874:127.
Euconnus (Microscydmus) debilis (Sharp); Csiki 1919:55; Franz 1976a:59.
Microscydmus gregarius Kurbatov 1988:1743, fig. c. RUSSIA
(Jewish Autonomous)
Neuraphes (Pararaphes) filiulus Reitter 1896:65; Csiki 1919:23. RUSSIA (Irkutsk)
Neuraphes (Pararaphes) fraterculus Reitter 1896:66; Csiki 1919:23. RUSSIA
(Irkutsk)
Neuraphes (Pararaphes) niponensis Franz 1976a:53, 59, fig. 2. JAPAN
Neuraphes (s.str.) pudibundus Kurbatov 1988:1742, figs. a-b. RUSSIA (Amur)
Scydmoraphes japonicus Franz 1976a:54, 59, fig. 3. JAPAN
Scydmoraphes minutus (Chaudoir); Kurbatov 1988:1745. RUSSIA (Amur, Jewish
Autonomous)
Scydmaenus minutus Chaudoir 1845:186.
Stenichnus aemulator Kurbatov 1993b:594, fig. 4. RUSSIA (Primorski)
Stenichnus bicolor (Denny); Kurbatov 1993b:592. RUSSIA (Primorski)
Scydmaenus bicolor Denny 1825:56, 68, pl. 13 fig. 4.
Stenichnus dividus Kurbatov 1993b:592, figs. 2-3. RUSSIA (Primorski)
Stenichnus klapperichi Franz 1985:94, fig. 4. TAIWAN

- Stenichnus pollens* (Sharp); Csiki 1919:36; Franz 1976a:59. JAPAN
Scydmaenus pollens Sharp 1886:49.
Stenichnus saltuarius Kurbatov 1993b:591, fig. 1. RUSSIA (Primorski)
Stenichnus sibiricus (Reitter); Csiki 1919:38; Franz 1970:27. RUSSIA (Irkutsk)
Cyrtoscydmus sibiricus Reitter 1896:66.
Stenichnus taiwanicus Franz 1985:94, fig. 5. TAIWAN

SCYDMAENIINI

- Scydmaenus angustulus* Csiki 1919:78. JAPAN
Eumicrus angustus Sharp 1886:49.
Scydmaenus chinensis Franz 1988:23, figs. 1a–b. CHINA (Sichuan, Yunnan)
Scydmaenus cribratus (Sharp); Csiki 1919:72; Franz 1976a:59. JAPAN
Eumicrus cribratus Sharp 1886:50.
Scydmaenus (s. str.) *csikii* Franz 1985:111, fig. 23. TAIWAN
Scydmaenus curtippennis (Sharp); Csiki 1919:79; Franz 1976a:59. JAPAN
Eumicrus curtippennis Sharp 1886:49.
Scydmaenus exculcator Kurbatov 1993a:152, figs. a–b. RUSSIA (Primorski)
Scydmaenus (*Cholerus*?) *formosanus* Csiki 1937:6; Franz 1985:113. TAIWAN
Scydmaenus (s.str.) *fukiensis* Franz 1985:116, fig. 27. CHINA (Fujian)
Scydmaenus hainanensis O'Keefe n. sp. CHINA (Hainan)
Scydmaenus (*Mascarensia*) *kasuganus* Franz 1976a:58, 59, fig. 6. JAPAN
S. honshuensis Franz 1976a:57, 59. Nomen nudum in Figure 6 caption and catalog.
Scydmaenus (s.str.) *kiautunensis* Franz 1985:117, fig. 28. CHINA (Fujian)
Scydmaenus kunmingensis Franz 1988:24. CHINA (Sichuan, Yunnan)
Scydmaenus nikitskii Kurbatov 1988:1744, figs. g–j; Kurbatov 1993a:155 RUSSIA (Primorski)
Scydmaenus obuncatus Kurbatov 1993a:153, 155, figs. e–f. RUSSIA (Primorski)
Scydmaenus punctatissimus Franz 1975:172, fig. 2; Kurbatov 1993a:155, figs. c–d. RUSSIA (Primorski)
Scydmaenus reversus Sharp 1874:128; Csiki 1919:73; Franz 1976a:59. JAPAN
Eumicrus reversus (Sharp); Sharp 1886:50.
Scydmaenus sinensis Franz 1968:537, fig. 1. CHINA (Sichuan)
Scydmaenus szechuanensis Franz 1968:538, fig. 2. CHINA (Sichuan)
Scydmaenus (*Eustemmus*) *taihorinus* Reitter 1914:268; Csiki 1919:77; Franz 1985:112. TAIWAN
Scydmaenus (*Nepaloscydmaenus*) *taiwanensis* Franz 1985:113. TAIWAN
Scydmaenus (s. str.) *taiwanicus* Franz 1985:112, fig. 24. TAIWAN
Scydmaenus takaranus Nakane 1963:22; Franz 1976a:59. JAPAN
Scydmaenus (s. str.) *vestitus* (Sharp); Reitter 1914:267; Csiki 1919:85; Franz 1985:109, fig. 21. JAPAN
Eumicrus vestitus Sharp 1874:126; Sharp 1886:49
Scydmaenus (s.str.) *vestitoides* Reitter 1914:268; Csiki 1919:85; Franz 1985:110, fig. 22. TAIWAN
Scydmaenus hoabinhensis Lhoste 1938:114. Placed as a possible synonym by Franz 1985:110.

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LITERATURE CITED

- Blatný, C. 1925. Fauna Sumatrensis (Beitrag Nr. 24). Scydmaenidae (Col.). Supplementa Entomologica 14:1–13.
- Chaudoir, M. de. 1845. Notices entomologiques sur le gouvernement et la ville de Kiew. (*Pselaphes*). Bulletin de la Société Impériale des Naturalistes de Moscou 18:158–213.
- Csiki, E. 1919. Scydmaenidae. In: Coleopterorum Catalogus, Pars 70. Ed., S. Schenckling. W. Junk, Berlin. 106 pp.
- Csiki, E. 1937. Beschreibung neuer Coleopteren. Entomologisches Nachrichtenblatt 11:5–7.
- Denny, H. 1825. Monographia Pselaphidarum et Scydmaenidarum Britanniae: or an essay on the British species of the genera *Pselaphus*, of Herbst, and *Scydmaenus*, of Latreille: in which those genera are subdivided, and all the species hitherto discovered in Great Britain are accurately described and arranged, with an indication of the situations in which they are usually found. S. Wilkin. Norwich. vi + 74 pp.
- Franz, H. 1961. Zur Kenntnis der Scydmaenidenfauna von Fernando Poo und Spanisch Guinea (Coleoptera). Eos, Revista Española de Entomología 37:161–210.
- Franz, H. 1962. Scydmaeniden aus dem Raume im Südwesten der Sahara. Bulletin de l'Institut Français d'Afrique Noire 24:1030–1048.
- Franz, H. 1968. Zwei neue *Scydmaenus*-Arten aus China (Col. Scydmaenidae). Eos, Revista Española de Entomología 43:537–539.
- Franz, H. 1970. Beiträge zur Kenntnis der Scydmaenidenfauna Asiens. Koleopterologische Rundschau 48:27–29.
- Franz, H. 1971a. Eine neue *Scydmaenus*-Art aus dem Sudan. Koleopterologische Rundschau 49:9–10.
- Franz, H. 1971b. Untersuchungen über die paläarktischen Arten der Gattungen *Euthia* Steph. und *Veraphis* Casey (Col. Scydmaenidae). Eos, Revista Española de Entomología 46:57–83.
- Franz, H. 1975. Ergebnisse der Bhutan—Expedition 1972 des Naturhistorischen Museums in Basel, Coleoptera: Fam. Scydmaenidae. Entomologica Basiliensia 1:171–185.
- Franz, H. 1976a. Neue Scydmaeniden aus Japan, sowie Bemerkungen zu bekannten Arten. Entomologische Blätter für Biologie und Systematik der Käfer 72:51–60.
- Franz, H. 1976b. Zwei neue *Scydmaenus*-Arten aus der äthiopischen Region (Coleoptera, Scydmaenidae). Revue de Zoologie Africaine 90:971–974.
- Franz, H. 1979. Die Scydmaeniden Südafrikas und Rhodesiens sowie Beschreibung einiger Arten aus Mozambique und Südwestafrika/Namibia (mit ausschluss der Triben Cephenniini und Mastigini) (Coleoptera: Scydmaenidae). The Entomological Society of Southern Africa Memoir 13:1–122.
- Franz, H. 1982. Revision der Scydmaeniden Äthiopiens (Col.). Koleopterologische Rundschau 56:9–54.
- Franz, H. 1983. Scydmaeniden des Ungarischen Naturwissenschaftlichen Museums in Budapest aus Südostasien: Sri Lanka, Thailand und Vietnam. Folia Entomologica Hungarica 44:175–187.
- Franz, H. 1985. Neue und ungenügend bekannte Scydmaeniden (Coleoptera) aus Taiwan, Fokien und Thailand. Mitteilungen der Münchner Entomologische Gesellschaft 74:91–128.
- Franz, H. 1986. Monographie der Scydmaeniden (Coleoptera) von Madagaskar (mit Ausschluss

- der Cephenniini). Österreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, 125:1–393.
- Franz, H. 1988. Zwei neue *Scydmaenus*-Arten aus Süd-China (Coleoptera, Scydmaenidae). *Elytron* 2:23–26.
- Franz, H. 1989. 4. Beitrag zur Scydmaenidenfauna von Thailand (Die Scydmaenidenausbeute von D.H. Burckhardt u. I. Löbl). *Revue Suisse de Zoologie* 96:33–80.
- Franz, H. 1995. *Euconnus lijingkei* spec. nov. aus Nordkorea (Insecta, Coleoptera, Scydmaenidae). *Entomologische Blätter für Biologie und Systematik der Käfer* 91:35–36.
- Hansen, M. 1997. Phylogeny and classification of the Staphyliniform beetle families (Coleoptera). *Biologiske Skrifter det Kongelige Danske Videnskabernes Selskab* 48:1–339.
- Hisamatsu, S. 1985. Notes on some Japanese Coleoptera, I. *Transactions of the Shikoku Entomological Society* 17:5–13.
- Kurbatov, S. A. 1988. On the study of beetles from the family Scydmaenidae (Coleoptera) in Far East of the USSR (in Russian). *Zoologicheskii Zhurnal* 67(11):1742–1745.
- Kurbatov, S. A. 1990a. More on the tribe Euthiini (Coleoptera, Scydmaenidae) in the USSR far east (in Russian). *Zoologicheskii Zhurnal* 69(2):136–139.
- Kurbatov, S. A. 1990b. Contribution to the knowledge of the beetles of the tribe Euthiini (Coleoptera, Scydmaenidae) of the Soviet Far East. *Entomological Review* 69:79–83.
- Kurbatov, S. A. 1991. New data for the fauna of beetles tribe Euthiini (Coleoptera, Scydmaenidae) from the Far East of the USSR (in Russian). *Zoologicheskii Zhurnal* 70(9):153–155.
- Kurbatov, S. A. 1993a. Beetles of the genus *Scydmaenus* (Coleoptera, Scydmaenidae) from the Russian Far East (in Russian). *Zoologicheskii Zhurnal* 72(10):152–155.
- Kurbatov, S. A. 1993b. Scydmaenid beetles of the genera *Stenichnus* Thoms. and *Euconnus* Thoms. (Coleoptera, Scydmaenidae) of Russian Far East (in Russian). *Entomologicheskoye Obozreniye* 72:591–596.
- Kurbatov, S.A. 1995. Sur les Euthiini et Cephenniini (Coleoptera, Scydmaenidae) de l'Extrême-Est de la Russie et du Japon. *Revue Suisse de Zoologie* 102:943–959.
- Lhoste, J. 1938. Étude de quelques Scydmaenidae des rives de l'Océan Indien (Coleoptera). *Arbeiten über Morphologische und Taxonomische Entomologie* 5:109–127.
- Nakane, T. 1963. New or little known Coleoptera from Japan and its adjacent regions. XVII. *Fragmenta Coleopterologia* 5:21–22.
- Newton, A. F. and H. Franz. 1998. World catalog of the genera of Scydmaenidae. *Koleopterologische Rundschau* 68:137–165.
- O'Keefe, S. T. 1998. "Zur Kenntnis der Scydmaeniden der Welt": The contributions of Herbert Franz to scydmaenid taxonomy 1952–1997 (Coleoptera: Scydmaenidae). *Koleopterologische Rundschau* 68:119–136.
- Reitter, E. 1887. Neue Coleopteren aus Europa, den angrenzenden Ländern und Sibiren, mit Bemerkungen über bekannten Arten. Dritter Theil. *Deutsche Entomologische Zeitschrift* 31:241–288.
- Reitter, E. 1891. Neue Coleopteren aus Europa, den angrenzenden Ländern und Sibiren, mit Bemerkungen über bekannten Arten. Zwölfter Theil. *Deutsche Entomologische Zeitschrift* 35:17–36.
- Reitter, E. 1896. Dreizehnter Beitrag zur Coleopteren-Fauna des russischen Reiches. *Wiener Entomologische Zeitung* 15:64–77.
- Reitter, E. 1914 (1913). H. Sauter's Formosa-Ausbeute. Scydmaenidae. *Entomologische Mitteilungen* 2:265–268.
- Sawada, K. 1962. Sur deux formes nouvelles des Cephenniini du Japon (Coléopt. Scydmaenidae). *The Entomological Review of Japan* 14:19–20.
- Sharp, D. 1874. The Pselaphidae and Scydmaenidae of Japan. *Transactions of the Entomological Society of London* 1874:105–129.
- Sharp, D. 1886. The Scydmaenidae of Japan. *Entomologist's Monthly Magazine* 23:46–51.

**A REVIEW OF THE GENUS *PHYSOCORYNA*
GUÉRIN-MÉNEVILLE, 1844
(COLEOPTERA: CHRYSOMELIDAE: HISPINAE)**

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Abstract.—The species of *Physocoryna* are reviewed and a key to the three species is presented. A lectotype is designated for *P. parvula* Weise.

Key words: Physocoryna; Hispinae; Chrysomelidae.

The genus *Physocoryna* contains three species (Uhmman 1957). Identifications have been based on descriptions or previously identified material.

The name *Physocoryna* first appeared in Chevrolat (1837) and contained three species names (*clavicornis* Dejean, *costata* Dejean, and *scabra* Dejean). All of these names are *nomina nuda* since there were no species descriptions or indications with the names. *Physocoryna* was validated by Guérin-Méneville (1844) when he described the new species *scabra* from Brazil. Weise (1921) described *parvula* from Paraguay. Pic (1925) described *expansa* from French Guiana. Uhmman (1932) synonymized *Octotoma tessellata* Maulik with *P. scabra* and described *dilatata* from Brazil. Uhmman (1937) transferred *dilatata* to *Acritispa* Uhmman.

The only other taxonomic reference to *Physocoryna* was Baly (1885) where plate 4, figure 3 was mislabeled as *P. scabra*. That text is correct in stating that the species is *Brachycoryna pumila* Guérin-Méneville.

The authorship of *Physocoryna* has been attributed to three authors. Chevrolat (1837) does not meet the requirements of ICZN (1985) Article 12(a), so the name may not be attributed to him. Chapuis (1875) published a description of the genus but gave the authorship to Chevrolat. Gemminger & von Harold (1876) and Donckier (1899) attempted to correct this error but gave the authorship to Chapuis apparently overlooking Guérin-Méneville (1844). Guérin-Méneville (1844) is the author since he provided an indication of the genus by attaching *Physocoryna* to the new species *scabra* [ICZN (1985) Article 2(b)6].

The genus *Physocoryna* belongs to the tribe Uroplatini. The tribe contains 32 genera (Uhmman 1957). *Physocoryna* can be distinguished by the very short, 7-segmented, clavate antennae, the eight rows of elytral punctures, the symmetrical elytral sculpture, and the elytral costae being irregular and tuberculate.

For this study, measurements were taken with an ocular micrometer. Pronotal length and width were taken along the midlines. Elytral width was measured at the humeri. Elytral length was measured from the base to the apex. Total length was measured from the base of the antennae to the apex of the elytra. In recording label data from type specimens, a slash (/) divides data on different labels. A question mark (?) in recorded label data indicates unreadable writing.

Physocoryna Guérin-Ménéville

Physocoryna Guérin-Ménéville 1844:279; Weise 1910:145, 1911a:30, 1911b:43; Uhmann 1933:80, 1937:336; Monrós & Viana 1947:256; Uhmann 1957:115; Seeno & Wilcox 1982:60; Staines 1989:343.

Physocoryna Chevrolat. Chapuis 1875:312 (Unavailable name [ICZN (1985) Article 8]).

Physocoryna Chapuis. Gemminger & von Harold 1876:3610; Donckier 1899:572; Blackwelder 1946:729; Papp 1953:90 (Invalid designation [ICZN (1985) Article 50]).

Type species. *P. scabra* Guérin-Ménéville (type by monotypy).

Generic description. Body elongate, attenuate. Head: small; medial sulcus absent; vertex with triangular depression. Antennae: clavate, very short; 7-segmented; segments I–III similar in size, as wide as long or III slightly longer than I or II; IV–VI transverse or IV and VI laterally compressed; VII much wider than preceding, oval, with whorls of setae, hirsute. Pronotum: tooth present in each anterior angle; transverse; covered with irregular pits. Elytra: parallel-sided; enlarged in exterior apical angle; apex almost truncate; surface with 8 rows of strong, confused punctures; puncture row 1 visible on basal half, interrupted by tubercles; sculpturing symmetrical; lateral and apical margins serrate. Venter: prosternum broad. Legs: short; tarsi wide, segment 1 short, 2 twice as large as 1, 3 as long as the preceding two combined, 4 slightly exceeding lobes of 3.

KEY TO THE SPECIES OF *PHYSOCORYNA*

1. Elytra greatly expanded to apex; pronotum without medial callus; pronotum with basal impression; antennal segment VII triangular; larger species (7 mm); French Guiana, Panama, and Costa Rica *expansa* Pic
- Elytra not greatly expanded to apex; pronotum with medial callus; pronotum without basal impression; antennal segment VII not triangular; smaller species (less than 6 mm) 2
2. Antennal segments IV–VI transverse; lateral margins of pronotum parallel-sided; anterior angle of pronotum with two teeth; larger species (4–5.5 mm); Argentina, Brazil, Colombia, Paraguay, and Peru *scabra* Guérin-Ménéville
- Antennal segments IV and VI laterally compressed; lateral margins of pronotum sinuate; anterior angle of pronotum with large rounded tooth; smaller species (3–3.6 mm); Brazil, Paraguay *parvula* Weise

Physocoryna expansa Pic

Physocoryna expansa Pic 1925:1 (Holotype: Cayenne/Type/Type/Museum Paris Coll. M. Pic (blue label)/*Physocoryna expansa* n. sp. [MNHN]). Uhmann 1937:337; Blackwelder 1946:729; Uhmann 1950:268; Papp 1953:90; Uhmann 1957:115.

Description. Black with reddish-brown markings; abdomen reddish; legs reddish with black markings. Head: vertex punctate; alutaceous; medial fovea present. Antennae: greatly expanded at apex; segment I subglobose, slightly compressed laterally; II small, transverse; III cylindrical, longer than II or IV; IV short, transverse; V transverse, longer than IV; VI short, transverse; VII large, triangular, compressed laterally. Pronotum: slightly transverse; convex; deeply, roughly punctate; anterior margin distinctly dentate; basal impression present; lateral margin bisinuate; each

anterior angle with rounded tooth present; distinct notch present just behind anterior angle; surface alutaceous; pronotal length 1.1 mm ($n = 4$); pronotal width 1.6 mm. Scutellum: reddish; quadrate; alutaceous. Elytra: greatly dilated at apex; exterior apical angle tridentate and laminate; lateral and apical margins dentate, lateral margins more dentate apically; irregular costae and plicae present over surface; humeri pronounced, with triangular oblique carina; elytral length 4.9 mm; elytral width 2.4 mm. Legs: protibiae sinuate, rounded apically, punctate; femora punctate, metafemora serrate on ventral margin. Venter: metasternum punctate laterally, reddish brown in middle, black laterally; mesosternum punctate medially; five visible abdominal sterna. Total length: 6.3–7.0 mm.

Host plant. Unknown.

Range. French Guiana, Panama, and Costa Rica.

Material examined. no locality (DEI). COSTA RICA, **Guanacaste:** Est. Pitilla, 700 m, 9 km S Sta. Cecilia, x.1990 (INBIO). **Heredia:** La Selva Biological Station, 3 km. south Rio Viejo, 10°26'N, 84°01'W, 26.vii.1998 (HAHC). FRENCH GUIANA: Cayenne (MNH). PANAMA: Barro Colorado Isl., 23.vi.1962 (AMNH). Total: 5.

Physocoryna parvula Weise

Physocoryna parvula Weise 1921:269 (Lectotype (here designated): Paraguay K. Fiebrig/? C 8171 (folded)/Weise det./TYPUS (red label)/*Physocoryna parvula* m/Syntypus (red label)/Coll. DEI Eberswalde/LECTOTYPE *Physocoryna parvula* Weise des. C. L. Staines 1997 (red label) [DEI]). Blackwelder 1946:729; Papp 1953:90; Uhmann 1957:115.

Description. Body yellowish with black markings. Head: vertex with triangular fovea which becomes a carina; surface micropunctate, slightly alutaceous around fovea; frons projecting; carina present on outer margin of each eye; two rows of setae present on inner margin of each eye. Antennae: segment I transverse, slightly compressed laterally; II transverse; III cuspidate; IV–VI short, transverse, laterally compressed; VII oval, large club, laterally compressed, hirsute, banded dark and yellow. Pronotum: yellow; transverse; convex; with large irregular, dark punctures; medial callus present; lateral margins sinuate; each anterior angle with large, rounded tooth; surface micropunctate; pronotal length 0.6 ($n = 4$); pronotal width 0.9 mm. Scutellum: yellow; quadrate; micropunctate. Elytra: lateral margins strongly dentate; exterior apical angle with small dentate lamina; surface micropunctate; elytral punctures irregular; elytral length 2.7 mm; elytral width 1.3 mm. Legs: femora punctate; protibiae flared to apex. Total length: 3.0–3.6 mm.

Notes. Weise (1921) did not indicate the number of specimens used in the description of *parvula*. Wendt (pers. comm.) indicated that Weise's types from 1910 to 1926 are deposited in Naturhistoriska Riksmuseet (Stockholm) and that no other *parvula* specimens are present in the ZMHB. Lindskog (pers. comm.) found the pin with Weise's label of *P. parvula* but the specimen card only contained one leg. The DEI specimen is clearly labeled as a Weise syntype, the label data matches that of the original description and is hereby designated as the lectotype.

Host plant. Unknown.

Range. Brazil and Paraguay.

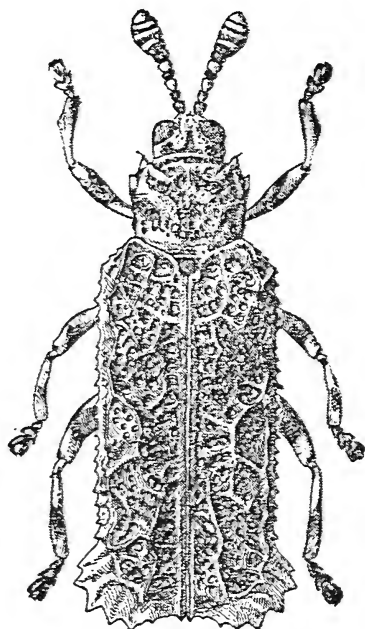


Fig. 1. *Physocoryna scabra* habitus.

Material examined. BRAZIL, Bahia (NHMW). **São Paulo:** São Paulo, 1–5.v.1961 (DEI). PARAGUAY: no further data (DEI). Total: 4.

Physocoryna scabra Guérin-Ménéville
(Fig. 1)

Physocoryna scabra Guérin-Ménéville 1844:279 (Type depository unknown). Chapuis 1875:312; Gemminger & von Harold 1876:3610; Donckier 1899:572; Weise 1911a:30, 1911b:43; Bondar 1930a:49, 1930b:179, 1931:74; Maulik 1937:139; Blackwelder 1946:729; Monrós & Viana 1947:258; Uhmman 1950:267; Papp 1953:90; Costa Lima 1955:211; Uhmman 1957:115, 1958:425; Godofredo *et al.* 1968:450.

Octotoma tessellata Maulik 1929:85 (Holotype: Type (white circle with red border)/BRAZIL Bahia 1928 on leaves of Canavalia Dr. G. Bondar 1227/Pres. by Imp. Bur. Ent. Brit. Mus. 1929–178/Octotoma tessellata M. S. Maulik TYPE 1928 [BMNH]). Bondar 1930a:49, 1930b:182; Uhmman 1932:266; Costa Lima 1936:327; Guérin 1953:102; Costa Lima 1955:211.

Description. Color yellow castanaceous with blackish maculae or entirely reddish-brown; parallel, compact, slightly convex, almost rectangular. Head: rugose; transverse; with short, deep medial fovea; medial carina present near base of antennae; two rows of setae present behind each eye; sulcus present on outer margin of each eye; surface micropunctate; frons projecting. Antennae: shorter than head and pronotum combined; segment I subglobose, longer than II; II transverse; III cuspidate, longer than II or IV; IV–VI transverse, V longer than IV or VI, IV and VI laterally

compressed; VII much wider, oval, with whorls of golden setae; I–VI longitudinally striate; I–V yellow castanaceous; VI–VII with paler irregular areas. Pronotum: quadrangular; parallel-sided; basal margin bisinuate; each anterior angle with two small projections present; surface finely punctate, with a smooth and shining central callus and lateral series of shallow pits; pronotal length 0.9–1.0 mm ($n = 30$); pronotal width 1.0–1.3 mm. Scutellum: transverse. Elytra: finely granulose; wider than pronotum; with three irregular, branched carinae situated before, after, and in the middle; sutural margin elevated; rows of punctures irregular and interrupted by the carinae; lateral margins asymmetrically dentate; exterior apical angle with dentate lamina; elytral length 3.7–4.0 mm; elytral width 1.7–2.1 mm. Legs: short, robust; tibiae flared to apex, mesotibiae somewhat curved; metatibiae long; meso- and metafemora punctate; metafemora serrate on inner margin. Venter: mesosternum longitudinally torulose in middle, sides micropunctate; metasternum rugose at sides, smooth in middle. Total length: 4.0–5.5 mm.

Notes. One specimen in the NHMW is labeled as from the Guérin-Ménéville collection. While it is impossible to determine if it is from the original series it does indicate that the species is the one Guérin-Ménéville described.

Larval host plants. *Canavalia* sp., *C. ensiformis* (L.) DC., *Cymbosema* sp., *Dioclea* sp., *Phaseolus* sp. (Fabaceae); and *Stimatophyllum* sp. (Malpighiaceae) (Bondar 1931; Godofredo *et al.* 1968).

Range. Brazil, Colombia, Peru, Paraguay, and Argentina.

Material examined. ARGENTINA, **Misiones:** v.1947 (USNM); San Javiez, 4.vii.1937 (USNM). BRAZIL: no further data (DEI, MCZC, NHMW). Chapada (CMNH); Barro Preto (USNM). Bahia (BMNH, DEI, USNM). **Goiás:** Jathay (NHMW). Jathay, ix–xi. 1987 (DEI), 1895–1896 (USNM); Rio Verde (DEI). **Pará:** Ithanhaem (DEI); Curua R., E of Santarem, 2°S54°W, IV-30–63 (MCZC). **Rio Grande do Sul:** 23.x.1967, 24.x.1965 (DEI). **Rio de Janeiro:** no further data (NHMW); Laguna de Sacuaresma, ix.1884 (USNM). **Santa Catarina:** Nova Teutonia, 20.ii.1935, 23.xi.1935 (DEI); 10-27.x.1942 (AMNH). COLOMBIA, **Meta:** Restrepo, 2.x.1965 (USNM). FRENCH GUIANA: no further data (USNM). PARAGUAY, **Dep. Itupúa Cordillera:** San Rafael Estancia Parabel, 20.ii.1991 (CLS). PERU, **Junín:** Satipa (USNM). **San Martín:** Tarapoto (USNM). TOTAL: 47.

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LITERATURE CITED

- Baly, J. S. 1885. Hispidae. in F. D. Godman & O. Salvin (eds.). *Biologia Centrali-Americana. Zoology, Insecta, Coleoptera, Phytophaga*. 6(2):1–124. London.

- Blackwelder, R. E. 1946. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America. United States National Museum Bulletin 185(4):551–763.
- Bondar, G. 1930a. Insectos damninhos e molestias dos feijões na Bahia. Boletim do Laboratorio de Pathologia Vegetal do Estado da Bahia 9:1–83.
- Bondar, G. 1930b. Hispíneos minadores das folhas dos feijões. Correio Agrícola Bahia 8:179–182.
- Bondar, G. 1931. Notas biológicas sobre alguns hispíneos observados na Bahia. O Campo 2: 74–75.
- Chapuis, F. 1875. Histoire naturelle des insectes. In: T. Lacordaire. Genera des Coléoptères. Vol. 11. Famille des Phytophages. Paris. 420 pp.
- Chevrolat, L. A. A. 1837. In: P. F. M. A. Dejean. Catalogue des Coléoptères de la collection de M. le comte Dejean, 3rd edition. Paris. 503 pp.
- Costa Lima, A. M. 1936. Terceiro catálogo dos insetos que vivem nas plantas do Brasil. Ministério da Agricultura Departamento Nacional da Produção Vegetal, Escola Nacional Agronomia, Rio de Janeiro. 460 pp.
- Costa Lima, A. M. 1955. Insetos do Brasil. 9º Tomo, Capítulo XXIX Coleópteros. 3.a Parte. Escola Nacional de Agronomia Série Didática No. 11. 289 pp.
- Donckier de Donceel, H. 1899. Catalogue Systématique des Hispides. Annales de la Société Entomologique de France 68:540–615.
- Gemminger, M. & E. von Harold. 1876. Catalogus Coleopterorum hucusque descriptorum synonymicus et systematicus. Vol. 12. Williams & Norgate. London.
- Godofredo d'Araújo e Silva, A., C. R. Gonçalves, D. M. Galvão, A. J. L. Gonçalves, J. Gomes, M. Nascimento Silva, & L. de Simoni. 1968. Quarto catálogo dos insetos que vivem nas plantas do Brasil. Parte 11, 1.º Tomo. Ministério da Agricultura, Departamento de Defesa Sanitária Vegetal, Rio de Janeiro. 622 pp.
- Guérin, J. 1953. Coleopteros do Brasil. Editado Pela Faculdade de Filosofia Ciências E Letras de Universidade de São Paulo. 356 pp.
- Guérin-Ménéville, F. E. 1844. Iconographie de règne animal de G. Cuvier, Vol. 7 Insectes. Paris. 576 pp.
- ICZN. 1985. International Code of Zoological Nomenclature. University of California Press. Berkeley. 338 pp.
- Maulik, S. 1929. New injurious Hispinae. Bulletin of Entomological Research 20:81–94.
- Maulik, S. 1937. Distributional correlation between hispine beetles and their host-plants. Proceedings of the Zoological Society of London Series A:129–159.
- Monrós, F. & M. J. Viana. 1947. Revisión sistemática de los Hispidae Argentinos (Insecta, Coleop., Chrysomeloid.). Anales del Museo Argentino Ciencias Naturales "Bernardino Rivadavia" 42:125–324.
- Papp, C. S. 1953. The Hispinae of America. 3rd contribution for promoting the scientific results of the International Hylean Amazon Inst. in Manaus, Brazil. Portugaliae Acta Biologica (B)4:1–147.
- Pic, M. 1925. Nouveautés diverses. Mélanges Exotico-Entomologiques 44:1–32.
- Seeno, T. N. & J. A. Wilcox. 1982. Leaf beetle genera (Coleoptera: Chrysomelidae). Entomography 1:1–221.
- Staines, C. L. 1989. A new genus and species of Hispinae (Coleoptera: Chrysomelidae) from Central America. Proceedings of the Entomological Society of Washington 91:342–345.
- Uhmman, E. 1932. Südamerikanische Hispinen aus der Sammlung des Stettiner Museums und der meinigen. 38. Beitrag zur Kenntnis der Hispinen (Col. Chrys.). Stettiner Entomologische Zeitung 93:260–266.
- Uhmman, E. 1933. Drei neue Südamerikanische Hispinen. 41. Beitrag zur Kenntnis der Hispinen (Col., Chrys.). Folia Zoologica et Hydrobiologica 5:77–81.

- Uhmann, E. 1937. Übersicht über die ersten Gattungen der Uroplatini (Col. Chrys.). 67. Beitrag zur Kenntnis der Hispinen. Entomologische Blätter 33:336–337.
- Uhmann, E. 1950. Die Dekensulptur von *Octotoma* Suffr. und verwandten Gattungen. 118. Beitrag zur Kenntnis der Hispinae (Coleopt. Chrysom.). Revista de Entomología Rio de Janeiro 21:259–274.
- Uhmann, E. 1957. Coleopterorum Catalogus. Supplementa. Chrysomelidae: Hispinae, Hispinae Americanae. W. Junk, s'Gravenhage. Pars 35(1):1–153.
- Uhmann, E. 1958. Coleopterorum Catalogus. Supplementa. Chrysomelidae: Hispinae, Corrigenda et Addenda. W. Junk, s'Gravenhage. Pars 35(3):399–490.
- Weise, J. 1910. Zweiter Beitrag zur Kenntnis der Hispinen. Verhandlungen des Naturforschenden Vereines in Brünn 48:115–162.
- Weise, J. 1911a. Coleopterorum Catalogus. Chrysomelidae: Hispinae. W. Junk. Berlin. Pars 35: 1–94.
- Weise, J. 1911b. Coleoptera Phytophaga fam. Chrysomelidae, subfam. Hispinae. in P. Wytman (ed.), *Genera Insectorum*. Fasc. 125:1–123. Brussels.
- Weise, J. 1921. Amerikanische Hispinen. Archiv für Naturgeschichte 87A:263–274.

THE IMMATURE STAGES OF *PSYLLOBORA GRATIOSA* MADER, 1958 (COLEOPTERA: COCCINELLIDAE) WITH SOME BIOLOGICAL ASPECTS¹

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Abstract.—Eggs, larval instars and pupae of *Psyllobora gratiosa* Mader, 1958 are described and illustrated using scanning electron micrographs. Some notes about the life habits are also provided.

Psyllobora gratiosa is a South American representative of the cosmopolitan genus *Psyllobora* Chevrolat. With a few exceptions the immature stages of this genus have been ignored in taxonomic treatments.

Davidson (1921) described all stages of *P. taedata* LeConte and made some experiments with rose mildew and animal foods concluding that aphid and red spiders were refused by larvae and adults. Members of *Psylloborini* are known to feed on fungus, particularly the mildew type. According to Gordon (1985), mites and aphids have been recorded as hosts in the literature, but these data are probably a result of inaccurate observation.

Rees *et al.* (1994) presented an illustrated key to larvae of 46 of the 60 North American Coccinellidae including *Psyllobora*, represented by *P. vigintimaculata* (Say), and a glossary of terms modified from Gage (1920).

In this paper, eggs, larval instars and pupae are described using scanning electron micrographs prepared by the Centro de Microscopia Elettronica-Universidade Federal do Paraná.

The adults were kept in round plastic containers (0.9 cm diameter) with a piece of humidity filter paper and leaves of *Hydrangea hortensis* Sér. infested with *Oidium* sp. The eggs, larvae and pupae were preserved in Kahle-Dietrich solution for the drawing illustration.

IMMATURE STAGES

Description. *Egg.* Color pale translucent, oval, elongate, with no visible sculpturing (Fig. 15), with the base flat where it contacts the leaf surface, 0.75 mm long, 0.33–0.42 mm wide.

Larva. First, second and third instars: First, second and third instars are similar in shape, body slightly soft and the color of the first instar is translucent (Fig. 16), second and third instars are same as fourth instar. Setae of strumae are proportionally more slender and smaller.

First instar—body length 1.08–1.25 mm; widest diameter 0.42–0.67 mm.

Second instar—body length 1.92–2.42 mm; widest diameter 0.67–0.92 mm.

Third instar—body length 3.00–3.17 mm; widest diameter 0.92–1.00 mm.

Fourth instar: Length 3.67–4.67 mm; width 0.92–1.00 mm. Body elongate, usu-

ally widest on second or third thoracic segment, narrowed more posteriorly than towards head; moderately flattened on dorsal and ventral surfaces. Usually white grey spots on tergal plates, and two yellow lateral spots on the first abdominal segment (Fig. 1). Strumae of dorsal and lateral surfaces with each seta divided at apex (Fig. 4).

Head small, usually subrounded, slightly wider than long (Fig. 5). Epicranial suture slightly Y shaped; three well developed lateral ocelli. Antenna (Fig. 7) three segmented, first segment transverse, second slightly longer than wider with two thin setae, third segment small, rather indistinct, with a number of very short conical sensilla at apex (Fig. 8). Labrum rectangular or subsquare; mandible robust, with five teeth, serially arranged; retinaculum with two teeth and a strong mola (Fig. 3). Maxilla with a rudimentary galea; maxillary palpus with three segments, first and second with setae and third with small papillae (Fig. 6). Labium with prementum and postmentum fused together, with small palpus and apical sensory papillae. Four pair of strong setae between the maxillae and labium, many thin and smaller ones setae in middle of prementum (Fig. 6).

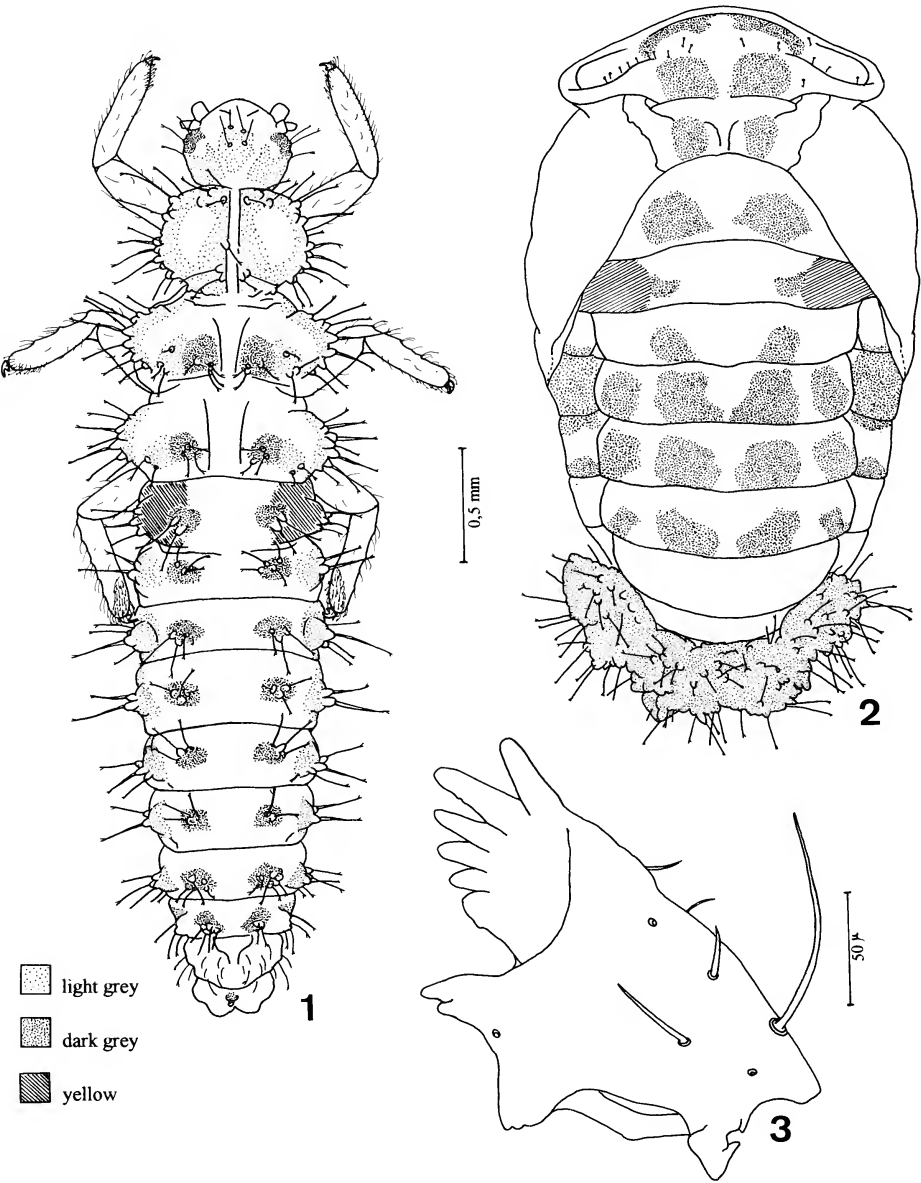
Pronotum strongly sclerotized, with two well developed plates with setae of various sizes distributed along anterior, lateral and posterior margins, disk concave, with longitudinal white band and lateral margins with chalazae. Meso and metanotum with two developed plates each with one central sclerotized struma and some chalazae together. Legs similar in structure on all segments, with small, sparse setae, except on inner side of tibiae where setae are dense, long and thickened at apices. Claw with triangular basal tooth, bent moderately to strongly pointed distally (Fig. 9).

Abdomen 10-segmented, not sclerotized; first eight segments each with pair of spiracles on dorsal surface and two pairs of strumae, one on dorsal and one on lateral surface (Fig. 10). The dorsal strumae are dark grey, lateral are light grey, each with five to seven chalazae (Fig. 1). First abdominal segment with two yellow lateral spots with strumae possessing black setae (Figs. 1, 17). Each pleural segment with a light strumae (Fig. 1). Ventral surface with four small strumae on each segment, with white setae without divided apices (Fig. 12). Between the chalazae of strumae there are groups of three to five short spines (Fig. 13).

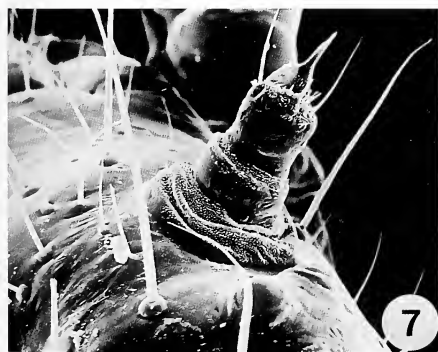
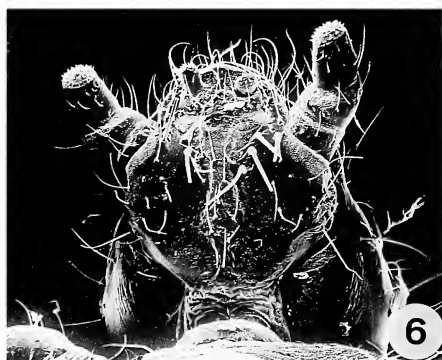
Pupa. Length 2.42–2.83 mm; width 1.50–1.67 mm. Whitish grey with dark brown spots on the thorax and abdomen (Figs. 2, 19). Head strongly deflexed, not visible from above. Pronotum sinuated laterally, distinctly arched and notched. Wing pad bare, extending to third abdominal segment. Pronotum with four spots, meso and metanotum transverses with two spots each. First abdominal tergum with two small brown spots in middle and two large lateral yellow spots; second tergum with two brown spots; third, fourth and fifth terga with four brown spots each. Third and fourth pleural segments with one or two brown spots.

DISCUSSION

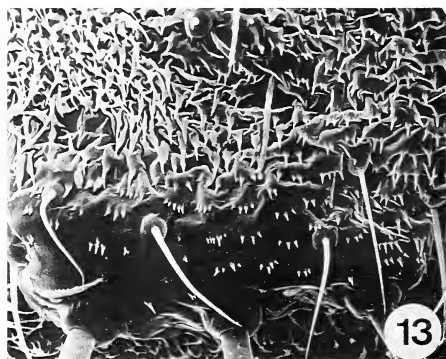
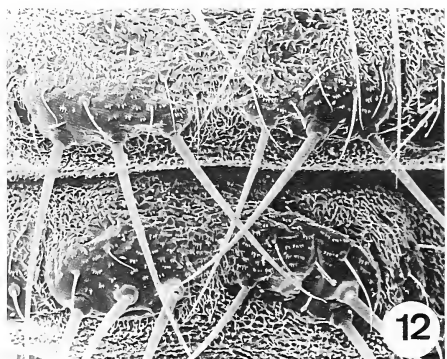
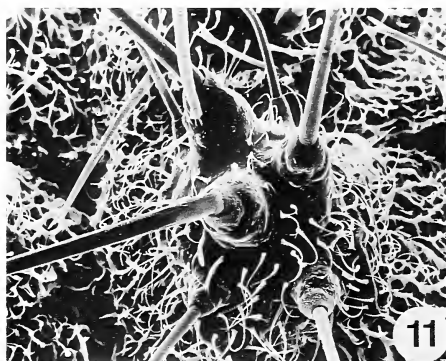
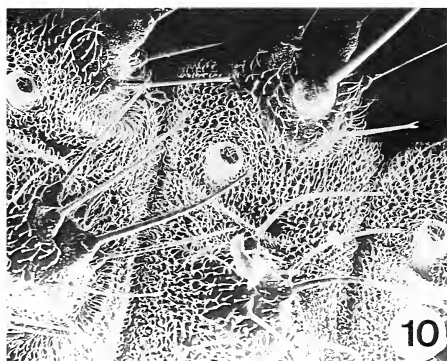
The mandible of *P. gratiosa* is very typical, with five teeth serially arranged. This kind of mandible is similar to other species that feed on fungi. The evident retinaculum with two teeth differs from the phytophagous species *Epilachna borealis* (Fabricius, 1775) referred by Rees *et al.* (1994), and also from *E. cacica* and *E. spreta*,



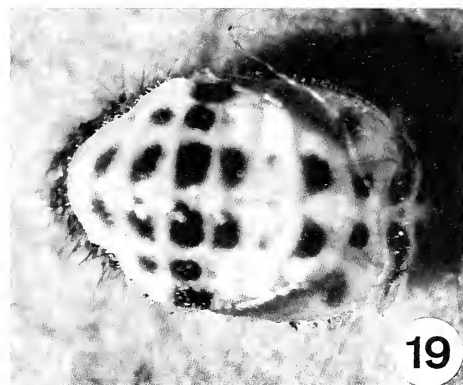
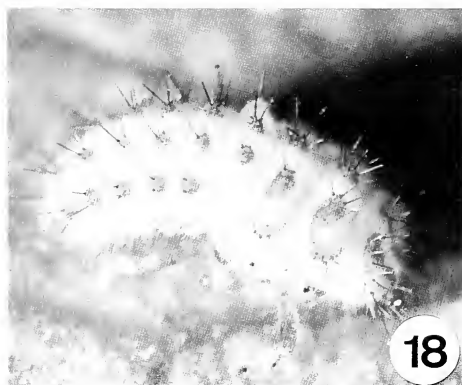
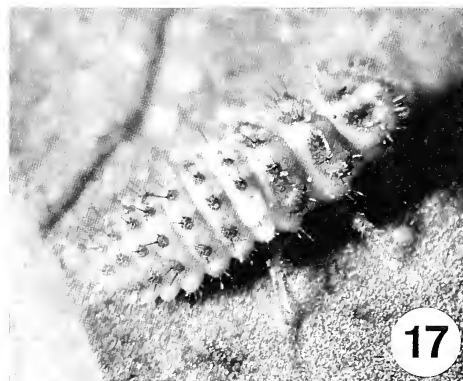
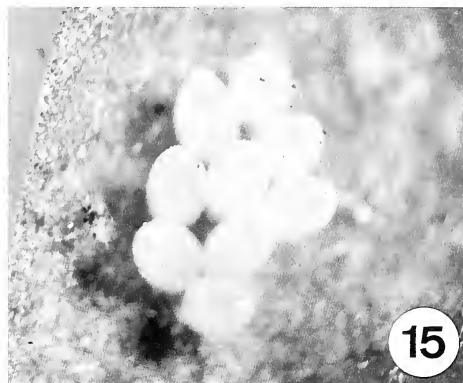
Figs. 1-3. *Psyllobora gratiosa*. 1. larva fourth instar (dorsal view); 2. pupa (dorsal view); 3. mandible.



Figs. 4–8. *Psyllobora gratiosa*. 4. setae of abdomen; 5. head (dorsal view); 6. head (ventral view); 7. antenna; 8. conical sensillae at apex of antenna.



Figs. 9–13. *Psyllobora gratiosa*. 9. claw; Abdomen: 10. lateral surface, 11. dorsal strumae, 12. ventral strumae, 13. integument spines (ventral).



Figs. 14–19. *Psyllobora gratiosa*. 14 adults; 15, eggs; 16, first larval instar; 17, fourth larval instar; 18, prepupa; 19, pupa.

two other South American species of this genus, which lack a retinaculum or mola (Almeida & Ribeiro, 1986 and Ribeiro & Almeida, 1989).

The strumae on dorsal and lateral surfaces of body differ from *Halyzia* and *P. vigintimaculata* because in *P. gratiosa* the setae are divided at the apex. This structure is unlike that of any previously studied species.

BIOLOGICAL DATA

Adults of *P. gratiosa* were collected in March of 1997 at Curitiba, Paraná, feeding on *Oidium* sp. from *Hydrangea hortensis* Sér., a very common plant in southern Brazil (Fig. 14). Eggs were attached to the surface of the leaves in small groups of 5 to 9 (Fig. 15), and all were fertile. The first larval instar was translucent (Fig. 16) and moved fairly fast to feed. The larvae (Fig. 17) fed using the five teeth of the mandible (Fig. 3) to grasp the fungus. Pupation occurred after the fourth instar became pale and inflated (Fig. 18) and took place on the inferior surface of the leaf (Fig. 19).

ACKNOWLEDGMENTS

We would like acknowledge to Dr. Daura Regina de Brito Eiras for the electron scanning micrographs.

LITERATURE CITED

- Almeida, L. M. & C. S. Ribeiro. 1986. Morfologia dos estágios imaturos de *Epilachna cacica* Guérin, 1844 (Coleoptera, Coccinellidae). *Revta bras. Ent.* 30(1):43–49.
- Davidson, W. M. 1921. Observations on *Psyllobora taedata* LeConte, a coccinellid attacking mildews (Coleoptera). *Entomol. News.* XXXII:83–89.
- Gage, J. H. 1920. The larvae of the Coccinellidae. University of Illinois Biological Monographs. 6:232–294.
- Gordon, R. D. 1985. The Coccinellidae (Coleoptera) of America North of Mexico. *J. N. Y. Entomol. Soc.* 93:1–912.
- Mader, L. 1958. Neue Coccinelliden (Col.). *Ent. Arb. Mus. Frey* 9:178–183.
- Rees, B. E., D. M. Anderson, D. Bouk & R. D. Gordon. 1994. Larval key to genera and selected species of North American Coccinellidae (Coleoptera). *Proc. Entomol. Soc. Wash.* 96:387–412.
- Ribeiro, C. S. & L. M. Almeida. 1989. Descrição dos estágios imaturos de *Epilachna spreta* (Muls., 1850) (Coleoptera, Coccinellidae), com redescritção, comentários e chave para três outras espécies. *Revta bras. Zool.* 6:99–110.

A NEW EULIINE GENUS FROM COSTA RICA AND VENEZUELA (LEPIDOPTERA: TORTRICIDAE)

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Abstract.—*Eubetia*, new genus, is described and illustrated from Central and South America. The new genus includes two species: *E. bigaulae*, new species, (type species) from Venezuela, and *E. boop*, new species, from Costa Rica. Adults are superficially most similar to *Anopina* Obratzov and *Odonthalitus* Razowski; male genitalia are most similar to *Anopinella* Powell. The male of *E. bigaulae* possesses a preponderance of putative secondary sexual characters, including the typical euliine foreleg hairpencil, a swollen area near the base of the forewing costa, a dense patch of elongate androconial scales on the lower surface of the forewing, modified scales in the anal and costal regions of the hindwing, and a band of specialized scales at the terminal edge of abdominal segment IX. In addition, the male of this species has an unusual row of dense, ascending scales on the lower frons, and forewing veins M_3 and CuA_1 are stalked; the latter two features are found in no other Euliini.

Key words: Neotropical, phylogeny, Euliini, systematics, secondary sexual structures.

In Lepidoptera, male secondary structures are considered to be of limited value in phylogenetic inference because they usually are evolutionarily more labile than other morphological features. Hence, their position in the transformation series “primitively absent-present-secondarily lost” cannot be determined with certainty. Nonetheless, the tortricid tribe Euliini is defined, in part, by the presence of a unique foreleg hairpencil in the male, although this structure is secondarily lost in many species and genera (Brown 1990; Brown & Powell 1991). In contrast to Olethreutinae (Tortricidae), where many members possess numerous and diverse male secondary structures (e.g., Brown 1983; Brown & Miller 1983), sexual structures are rare in Euliini (Tortricinae), with the exception of the foreleg hairpencil. A few species of *Anopina* Obratzov and one species of *Inape* Razowski have a patch of androconial scales along the costa of the upper surface of the hindwing; and one species of *Accuminulia* Brown has modified sex scales covering the basal one-half of the upper surface of the hindwing.

During continuing studies on the phylogeny and biogeography of the tortricid tribe Euliini, I discovered an undescribed species that possesses a preponderance of putative secondary sexual characters, including the typical euliine foreleg hairpencil, a densely scaled, swollen area near the base of the forewing costa, a dense patch of elongate androconial scales on the lower surface of the forewing, modified scales in the anal and costal regions of the hindwing, and a band of specialized scales around the terminal edge of abdominal segment IX. A new genus is described to accommodate this and a second new species.

MATERIALS AND METHODS

Taxonomic material was studied at the following institutions: The Natural History Museum (BMNH), London, England; Instituto Nacional de Biodiversidad (INBio), Santo Domingo, Costa Rica; Essig Museum of Entomology (UCB), University of California, Berkeley, U.S.A.; and National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C., U.S.A.

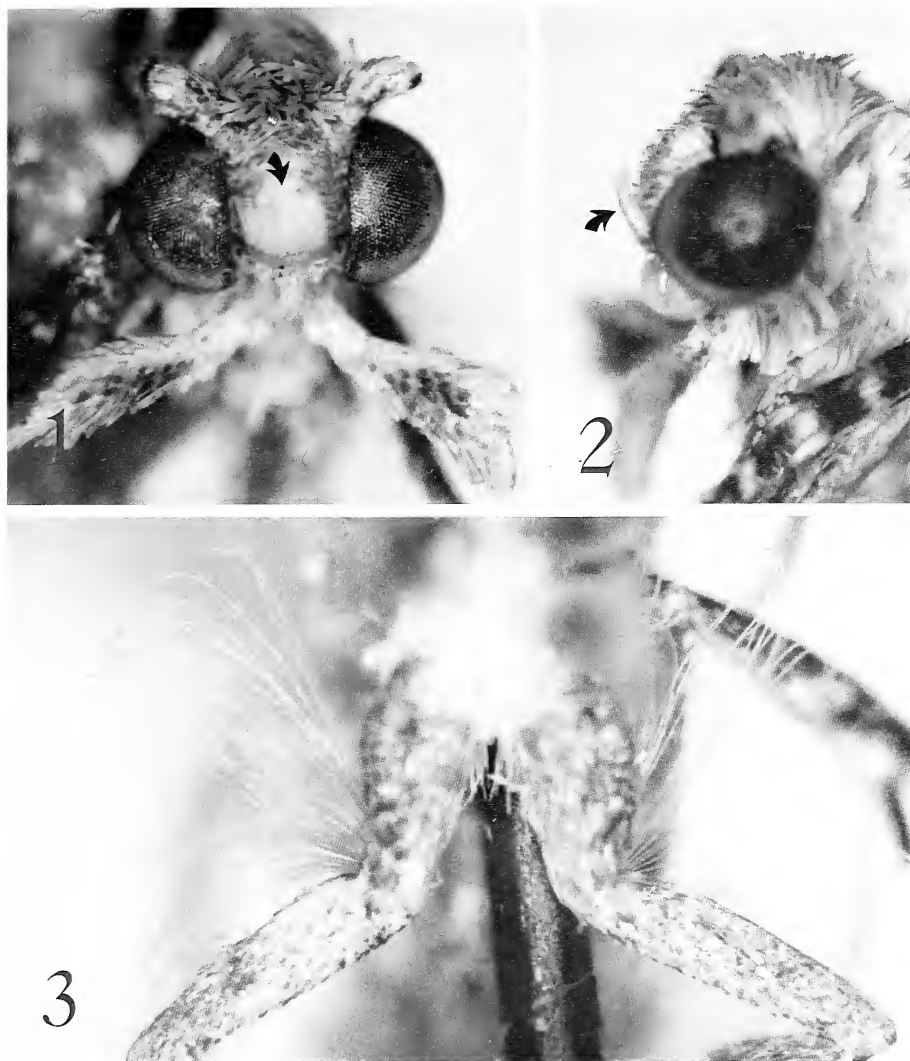
Dissection methodology follows that summarized in Brown and Powell (1991). Wing venation was studied through the examination of stained, slide-mounted preparations ($n = 2$) and by placing a drop of 95% ethanol on the wings of pinned, spread adult moths ($n = 4$). Illustrations of genitalia and wing venation were drawn either with the aid of a microprojector or a camera-lucida attachment. Forewing measurements were made with an ocular micrometer mounted in a dissecting microscope. Terminology for wing venation and genitalic structures follows Horak (1984). Abbreviations and symbols are as follows: FW = forewing; HW = hindwing; n = number of specimens examined; ca. = circa (approximately); \bar{x} = mean.

SYSTEMATICS

Eubetia, new genus

Type species. *Eubetia bigaulae*, new species.

Description. *Head.* Antennal cilia in male ca. 1.0–1.1 times width of flagellomere; cilia in female less than 0.1 times flagellar segment diameter. Labial palpus moderate in length, ca. 1.5 times horizontal diameter of eye; segment II weakly upturned, expanded distally by scaling; segment III ca. 0.2–0.3 as long as II, smooth-scaled, exposed. Maxillary palpus rudimentary. Proboscis well developed. Lower frons either smooth-scaled or with dense row of ascending scales (male of *E. bigaulae*; Figs. 1, 2); vertex usually with typical overhanging tuft of scales. Ocelli present. Chaetosema present. *Thorax:* Smooth-scaled. Male foreleg hairpencil present (Fig. 3). *Forewing* (Fig. 4): Length ca. 3.0 times width; length of discal cell ca. 0.60 FW length; greatest width of discal cell ca. 0.14 its length; CuA_2 originates ca. 0.5 along length of discal cell; CuA_1 and M_3 long-stalked (*E. bigaulae*) or separate (*E. boop*); CuP absent; chorda and M-stem absent. No upraised scale tufts; male without costal fold, with (*E. bigaulae*) or without (*E. boop*) swollen lobe at costa near wing base. Under surface with (*E. bigaulae*) or without (*E. boop*) patch of elongate androconial scales. *Hindwing* (Fig. 4): $Sc + R$ and Rs closely approximate; Rs and M_1 stalked or connate; M_3 and CuA_1 variably stalked; CuP present; M-stem absent; tuft of hairlike scales along $1A + 2A$, originating near base of wing. *Abdomen:* Dorsal pits absent; no modified corethroglyne scaling in female. *Male genitalia* (Figs. 7, 8): Uncus moderately long, gently curved, slightly broadened distally. Socius somewhat rounded, pendant, with fine setae, lacking conspicuous scales; not fused to gnathos. Gnathos arms slender, with an elongate, narrow distal plate at junction of arms, and lateral process either near base or middle. Subscaphium absent, although anal tube conspicuous; hami absent. Transtilla incomplete, with a pair of slender, attenuate processes basally, membranous at middle. Valva narrow, elongate, broadened apically, with eucosminelike cucullus covered with fine setae and perimeter of spines; basal portion of costa membranous, remainder sclerotized; sacculus weak, an elon-



Figs. 1–3. Head and forelegs of *E. bigaulae*. 1. Head, front view; 2. Head, side view. Arrows indicate ascending scales of lower frons; 3. Forelegs with hairpencil expanded.

gate spine- or thornlike processes from near mid-venter of valva. Pulvinus absent. Vinculum complete, well developed, v-shaped. Juxta an irregular plate. Aedeagus large, straight or only slightly curved, with or without strongly sclerotized distal appendages; cornuti in the form of irregularly angled sclerites. *Female genitalia* (Figs. 9, 10): Papillae anales moderately broad, flattened. Apophyses short and slender. Sterigma a simple, weakly scobinate band; antrum represented by a large, broad funnel. Ductus bursae moderately long, coiled one revolution, with irregular wrinkles

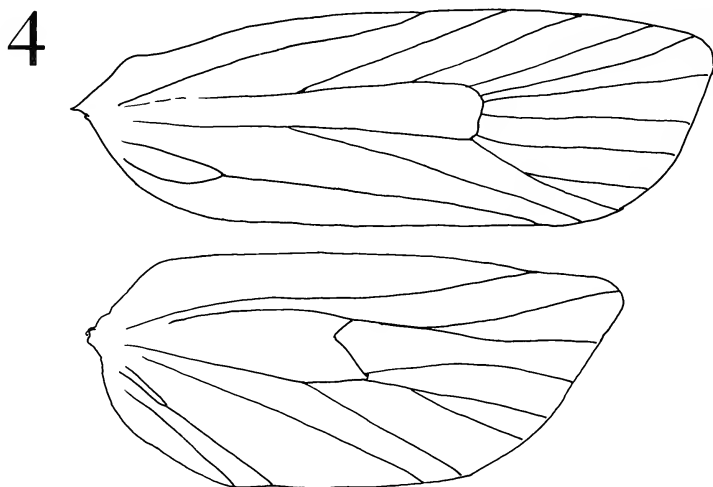


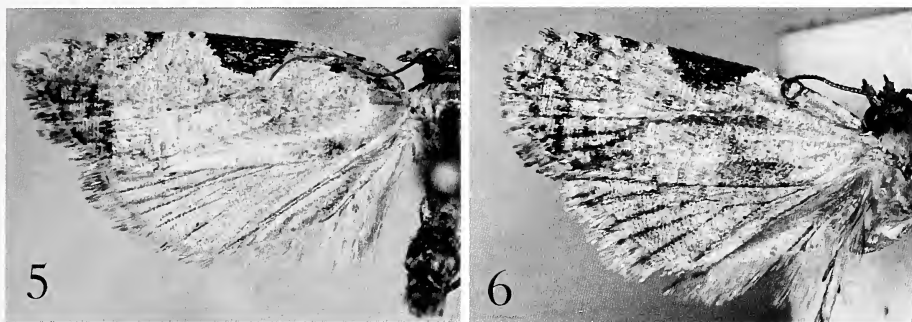
Fig. 4. Wing venation of male *Eubetia bigaulae*.

and punctations; colliculum developed in the form of a long, slender, irregular sclerite. Corpus bursae irregularly rounded; spicules and signum lacking. Accessory bursa absent. Ductus seminalis from proximal portion of corpus.

Discussion. Superficially, adults of *Eubetia* are similar to *Anopina* Obraztsov and *Odonthalitus* Razowski in forewing shape, length, and maculation. *Eubetia* can be distinguished from *Odonthalitus* by the absence of the basal patch on the forewing, the shorter antennal cilia in the male (1.0 vs. 3.0–4.0 times flagellar width), and the presence of a foreleg hairpencil in the male. *Eubetia* can be distinguished from *Anopina* by the more shallow semicircular patch from the costa of the forewing and the shorter antennal cilia in the male (1.0 vs. 3.0–5.0 times flagellar width). The male genitalia of *Eubetia* are unlike those of either *Anopina* or *Odonthalitus*, and are most similar to those of *Anopinella* Powell in the development of a eucosminelike cucullus in the valva and the presence of a spine- or thornlike process from near the mid-venter of the valva. The latter two features may represent synapomorphies for the two genera. Autapomorphies for *Eubetia* include the upturned apex of the costa of the valva, the elongate mesal distal plate at the joined gnathos arms, the large funnel-shaped antrum, and the wrinkly, coiled ductus bursae. The stalked condition of veins CuA_1 and M_3 in the forewing, the dense row of ascending scales on the lower frons, and the dense patch of elongate androconial scales on the under surface of the forewing of *E. bigaulae* are features found in no other Euliini species, not even in the congener *E. boop*.

Distribution and Biology. *Eubetia* is known from montane forest habitat at mid-elevations (1100–1500 m) in Costa Rica and Venezuela. Adults were collected at blacklight. Nothing is known of the early stages.

Etymology. The genus name is an arbitrary combination of letters and is considered a noun of feminine gender.



Figs. 5–6. Adult females of *Eubetia*. 5. *E. bigaulae*; 6. *E. boop*.

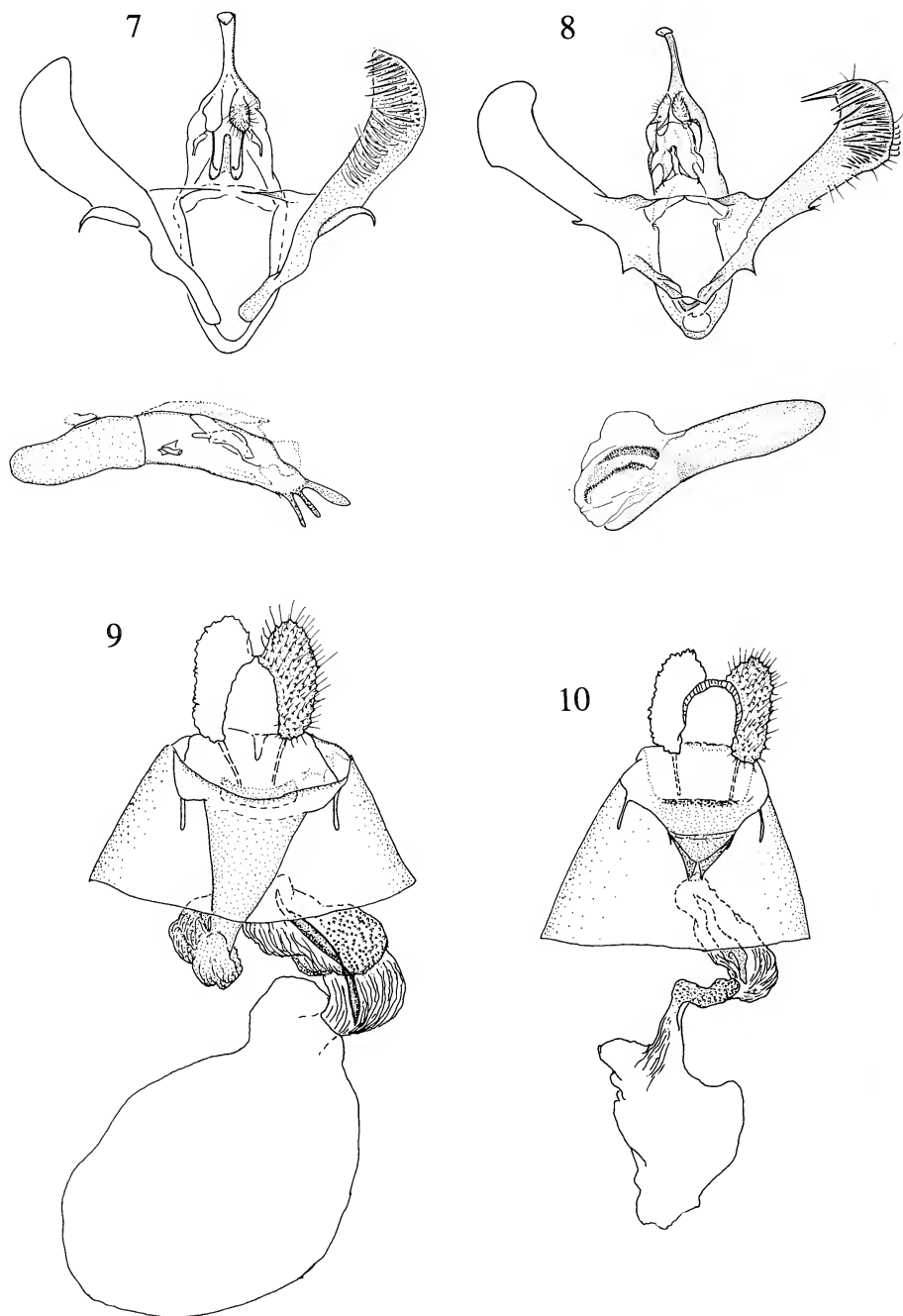
***Eubetia bigaulae*, new species**

Figs. 1–5, 7, 9

Description. *Male. Head.* Lower frons with dense row of ascending, light tan scales (Figs. 1, 2), upper frons smooth-scaled without overhanging tuft, tan, with whitish central portion; vertex pale tan, mixed with brown. Labial palpus pale orange-tan, mixed with brown mesally and laterally. Antennal scaling brown. *Thorax.* Pale yellow-gold with red-brown prothoracic collar. *Forewing* (Figs. 4, 5): Length 7.0–8.0 mm (\bar{x} = 7.4 mm; n = 10); slightly expanded lobe near base of costa. Upper side pale yellow with pinkish-tan and pale reddish-brown overscaling; reddish brown or brown semicircular patch bordering costa ca. 0.40–0.60 distance from base; small, irregular, brown spot at costa ca. 0.2 distance from base to apex, with a similar spot immediately below; usually with additional small brown spots along costa; diffuse red-brown semicircular patch in terminal region. Fringe pale tan-gray. Under side moderately uniform dark tan-brown; large patch of elongate androconial scales arising near base, extending nearly to apex of discal cell. *Hindwing.* Upper side light gray-brown, with larger, paler sex scales in anal region and along costa. Fringe grayish white. Under side light gray-brown. *Genitalia.* As in Fig. 7 (drawn from USNM slide 88637, Venezuela; n = 3). Tegumen rather long and narrow. Uncus slightly broadened apically. Socius rounded, pendant. Gnathos arms with slender lateral lobe near base. Valva narrow, broadest distally, with upturned apex; distal 0.5 of valva eucosminelike, with fine setae and spines; sacculus weakly differentiated, undulate at base; a long, slightly curved thorn from venter of valva ca. 0.5 distance from base to apex. Aedeagus broad, slightly curved, with three digitate, sclerotized processes distally; phallobase large; vesica with several irregular sclerites.

Female. FW length 6.5–8.0 mm (\bar{x} = 7.5 mm; n = 10) (Fig. 5). Superficially as in male, except forewing markings slightly more defined, and lacking foreleg hair-pencil and secondary sexual scaling on forewing and hindwing. *Genitalia.* As in Fig. 9 (drawn from USNM slide no. 88638, Venezuela; n = 2). Sterigma a broad, weakly spiculate band, with more strongly sclerotized patch just above ostium. Antrum large, funnel-shaped. Ductus bursae moderately long, coiled one revolution, with fine wrinkly lines; colliculum present in the form of an elongate, slightly curved band. Corpus bursae irregularly rounded.

Types. Holotype, ♂, VENEZUELA, Aragua, Rancho Grande, cloud forest [1100



Figs. 7-10. Genitalia of *Eubetia*, males with valvae spread, aedeagus removed. 7. Male genitalia of *E. bigaulae*; 8. Male genitalia of *E. boop*; 9. Female genitalia of *E. bigaulae*; 10. Female genitalia of *E. boop*.

m], 30–31.iii.1978, blacklight, J. B. Heppner (USNM). Paratypes: VENEZUELA, **Aragua**, Rancho Grande, 4♂♂, 5♀♀, 16–23.x.1966 (S. S. & W. D. Duckworth, USNM); 1♀, 1–5.xi.1966 (S. S. & W. D. Duckworth, USNM); 3♀♀, 7–8.vi.1967 (S. S. & W. D. Duckworth, USNM); 1♂, 8–14.vii.1967 (R. W. Poole, USNM); 1♂, 2♀♀, 22–31.vii.1967 (R. W. Poole, USNM); 1♂, 1♀, 22–31.viii.1967 (R. W. Poole, USNM); 3♀♀, 17–20.i.1978 (J. B. Heppner, USNM); 4♂♂, 7♀♀, 30–31.iii.1978 (J. B. Heppner, USNM); 2♂♂, 2♀♀, 1–3.iv.1978 (J. B. Heppner, USNM).

Distribution and Biology. *Eubetia bigaulae* is known only from Rancho Grande, Venezuela. With records from nearly every month, this species apparently flies throughout the year. Adults are attracted to lights.

Discussion. *Eubetia bigaulae* is easily distinguished from the following species, *E. boop*, by the presence of numerous unusual characters, including the dense row of ascending scales from the lower frons, the dense patch of androconial scales on the under surface of the forewing, the slightly expanded lobe near the base of the costa of the forewing, and the stalked condition of M_3 and CuA_1 (in both male and female). The venation, costal lobe, and frons scaling of the male of this species are unique within Euliini.

Etymology. The species name refers to the exclamation that followed its discovery—“its a new one, by golly.”

Eubetia boop, new species

Figs. 6, 8, 10

Description. *Male.* FW length 7.0 mm ($n = 1$). *Head:* Frons smooth-scaled, dark brown; vertex dark brown, mixed with tan. Labial palpus dark brown mesally and laterally. Antennal scaling brown. *Thorax:* Pale yellow-gold with brown prothoracic collar. *Forewing:* Upper side pale whitish yellow with dense, irregular, tan, yellow, and reddish-brown reticulations and overscaling; brown semicircular patch bordering costa ca. 0.40–0.60 distance from base; terminal region with patches of red-brown scales. Fringe grayish tan. Under side moderately uniform dark tan-brown. *Hindwing:* Upper side light gray-brown. Fringe dingy whitish. Under side light gray-brown. *Genitalia:* As in Fig. 8 (drawn from JWB slide 749, Costa Rica; $n = 1$). Tegumen rather tall and narrow. Uncus broadened apically, slightly longer than in *E. bigaulae*. Socius rounded, pendant. Gnathos arms with broadened, crescent-shaped lobe near middle. Valva narrow, broadest distally, with upturned apex; distal 0.25 of valva with eucosminelike fine setae and spines; sacculus with triangular process subbasally; slender, curved spine from venter of valva ca. 0.5 distance from base to apex. Aedeagus broad, slightly curved; phallobase large; vesica with two irregular sclerites.

Female. FW length 6.5 mm ($n = 1$) (Fig. 6). Superficially as in male, except markings slightly more defined and lacking foreleg hairpencil. *Genitalia:* As in Fig. 10 (drawn from JWB slide 748, Costa Rica; $n = 1$). Sterigma a moderately broad, weakly spiculate band; spiculae more developed mesally along dorsal margin. Antrum not as large relative to 8th segment as in *E. bigaulae*, funnel-shaped, with narrow-triangular sclerites near junction with ductus bursae. Ductus bursae moderately long, coiled one revolution, wrinkly; colliculum present in form of an irregular sclerite. Corpus bursae irregularly triangular, wrinkly (unmated and not expanded).

Types. Holotype, ♂: COSTA RICA, **Puntarenas Prov.**, Finca Cafrosa, Est. Las Mellizas, P. N. Amistad, 1300 m, i.1991, M. M. Chavarria & G. Mora (INBio). Paratype: COSTA RICA, **Puntarenas Prov.**, 1 ♀, Est. Biol. Las Alturas, Coto Brus,, 1500 m, ix.1991 (M. Ramirez, INBio).

Distribution and Biology. *Eubetia boop* is known only from middle elevations (1300–1500 m) in Puntarenas Province, Costa Rica. Given the intensity of collecting activities in Costa Rica as a result of the parataxonomist program associated with INBio, it is unusual that so few specimens of this species are available. Adults have been captured in January and September. Nothing is known of its life history.

Discussion. This species can be distinguished from *E. bigaulae* by the characters identified above in the diagnosis of that species. In addition, *E. boop* has a triangular process from the sacculus lacking in *E. bigaulae*.

Etymology. The species name is an arbitrary combination of letters.

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LITERATURE CITED

- Brown, J. W. 1990. Taxonomic distribution and phylogenetic significance of the male foreleg hairpencil in the Tortricinae (Lepidoptera: Tortricidae). *Entomol. News* 101:109–116.
- Brown, J. W. and J. A. Powell. 1991. Systematics of the *Chrysoxena* group of genera (Lepidoptera: Tortricidae: Euliini). *Univ. Calif. Publ. Entomol.* 111. 87 pp.
- Brown, R. L. 1983. Taxonomic and morphological investigations of Olethreutinae: *Rhopobota*, *Griselda*, *Melissopus*, and *Cydia* (Lepidoptera: Tortricidae). *Entomography* 2:97–120.
- Brown, R. L. and P. R. Miller. 1983. Studies of Lepidoptera hindwings with emphasis on ultrastructure of scales in *Cydia caryana* (Fitch) (Tortricidae). *Entomography* 2:261–295.
- Horak, M. 1984. Assessment of taxonomically significant structures in Tortricinae (Lep., Tortricidae). *Mitt. Schweiz. Entomol. Gesel.* 57:3–64.

FEMALES OF *CHIMARRA* (TRICHOPTERA: PHILOPOTAMIDAE) FROM EASTERN NORTH AMERICA

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Abstract.—Descriptions of females of the ten known eastern North American species of *Chimarra* are given and an identification key provided. Diagnostic characters are evident in the thickness of veins at the first fork of the radial sector in each forewing and in the shapes of the spermathecal sclerite and ventral plates beyond abdominal sternum VIII. A summary of published distributional records is provided for all *Chimarra* species of eastern North America.

The caddisfly genus *Chimarra* (Trichoptera: Philopotamidae), with 429 known species, occurs in all major biogeographic regions except Antarctica, with greatest diversity in the southern hemisphere (Morse, in preparation). Ten species of *Chimarra* occur in eastern North America, typically one or two species in most unpolluted streams. For purposes of this paper, "eastern" refers to Ontario, and the US states adjacent to either side of the Mississippi River and eastward.

The genus can be distinguished readily from other genera in larval and adult stages (Schmid 1980; Merritt and Cummins 1996; Wiggins 1996) and the males of the eastern North American species can be diagnosed using the revision of Lago and Harris (1987). However, neither the females nor the immature stages of these species can be identified with available literature. Consequently, studies which are dependent on the identification of these life stages are hindered, such as those concerning the behavior and ecology of mating and egg-laying adults or the delineation of different microhabitats. Furthermore, determinations of other ecological characteristics of the larvae and also their differential responses to various pollutants are difficult.

Discovery of species-diagnostic characters for caddisfly larvae requires association of larvae with identifiable adults. These adults may be affiliated with larvae either by rearing or by field techniques (Milne 1938; Merritt and Cummins 1996; Wiggins 1996). Therefore, knowledge of adult identification characteristics of both sexes of a species, rather than just of one sex, doubles the opportunity for identifying larvae.

Ross (1944) gave a key for the males and females of four of the five *Chimarra* species that were known in eastern North America at that time, *C. aterrima* Hagen, *C. feria* Ross, *C. obscura* (Walker), and *C. socia* Hagen. With the subsequent descriptions of five additional species, the total number of known *Chimarra* species in eastern North America has reached ten. Lago and Harris (1987) revised these species,

describing, illustrating, and keying males for all the eastern North American species of this genus, mapping the known distributions, and inferring their phylogeny. However, no successful attempts have been made to distinguish the females of this genus since 1944.

In this investigation, females were associated with identifiable males by simultaneous collection in light traps and by correspondence in color of body, wings, and appendages. This method of association is not as nearly certain as the capture of copulating specimens or the rearing of viable eggs from the results of such unions. However, the probability that the associations are correct is improved by the facts (1) that only ten morphologically distinguishable females were found, corresponding with the known number of males, and (2) that most of the collections included several specimens each of only one male and one female morphotype.

The usual method for studying genitalia of Trichoptera is to remove non-cuticular material with caustic potash (KOH) or other digesting substances as described, for example, by Ross (1944). This method was used to examine the female spermathecal sclerites in this study. However, the external characteristics were more distinctive for females that had not been prepared by this technique; cleared genitalia of female *Chimarra* tended to become distorted and the diagnostic ventral plates beyond abdominal sternum VIII lost their dark color more quickly than usual in the clearing process. Therefore, most specimens were studied externally in an uncleared condition, preserved in 75% ethyl alcohol. Drawings of these specimens were subsequently prepared using a Wild® M5 dissecting microscope equipped with a grid ocular in one eyepiece.

The specimens examined are deposited, as indicated, in the following institutions: Clemson University Arthropod Collection, Clemson, South Carolina (CUAC), Illinois Natural History Survey, Urbana, Illinois (INHS), University of Mississippi, University, Mississippi (UMS), and Clarion University, Clarion, Pennsylvania (CLAU).

Chimarra Stephens

We concur with Schmid (1980) in the opinion that abdominal segment IX in females of most species of Annulipalpia, including Philopotamidae, is absent or inconspicuous. In the females of *Chimarra*, there is a pair of plates ventrolaterally of tergum X, called "ninth sternum" by Ross (1944), but unnamed by any other authors we know. Typically there is no sternum of segment X (Ross' "segment IX") in Trichoptera males or females, such that these ventrolateral plates may have some other origin. Determination of the homology of these plates is beyond the scope of this investigation. Thus, we call them simply "ventral plates." Otherwise, the terminology of Nielsen (1980) is employed.

Adults: Bodies and appendages of eastern North American species tan to dark orange to near black, wings brown to black. Forewing with first fork of radial sector (rs) vein thickened in most species. Sternum VII with ventromesal projection.

Female terminal segments VIII–XI together obviously shorter than segment VII. Sternite and tergite VIII fused and forming sclerotized ring. Segment VIII with two, sometimes three, pairs of posteroventral setose spots and tergite VIII with one pair of posterolateral setose spots. Segment IX apparently absent. Segment X with tergum

divided longitudinally on meson and separate laterally from pair of ventral plates (discussed above), varying in size, shape, and sclerotization, always separated from each other by membrane on ventral meson. Segment XI forming pair of setose lobes, each lightly sclerotized, bulbous, and carrying a cercus apically. Vaginal apparatus membranous, carrying spermathecal sclerite anteriorly.

EASTERN NORTH AMERICAN *CHIMARRA* SPECIES

Females of eastern North American species of *Chimarra* differ from males not only in primary sexual characters, but also in size (females usually are slightly larger) and in the fact that the middle legs of females are natatorial, with the tibiae and tarsal segments tending to be flattened and fringed with hairs, especially the basal tarsal segment.

Lago and Harris (1987) provided a phylogeny of the eastern North American species of *Chimarra*. It will not be possible to infer a phylogeny of these same species based on female characters until the females of out-group species are known, determining the polarities of in-group character transformations. Thus we are not yet able to test the hypotheses of Lago and Harris (1987).

A summary of records for North American states and provinces (standard two-letter postal codes) is provided for each species below, with a few additions noted beyond the distributional records of Lago and Harris (1987) and Armitage (1983 and 1991).

Chimarra aterrima Complex Lago and Harris, 1987

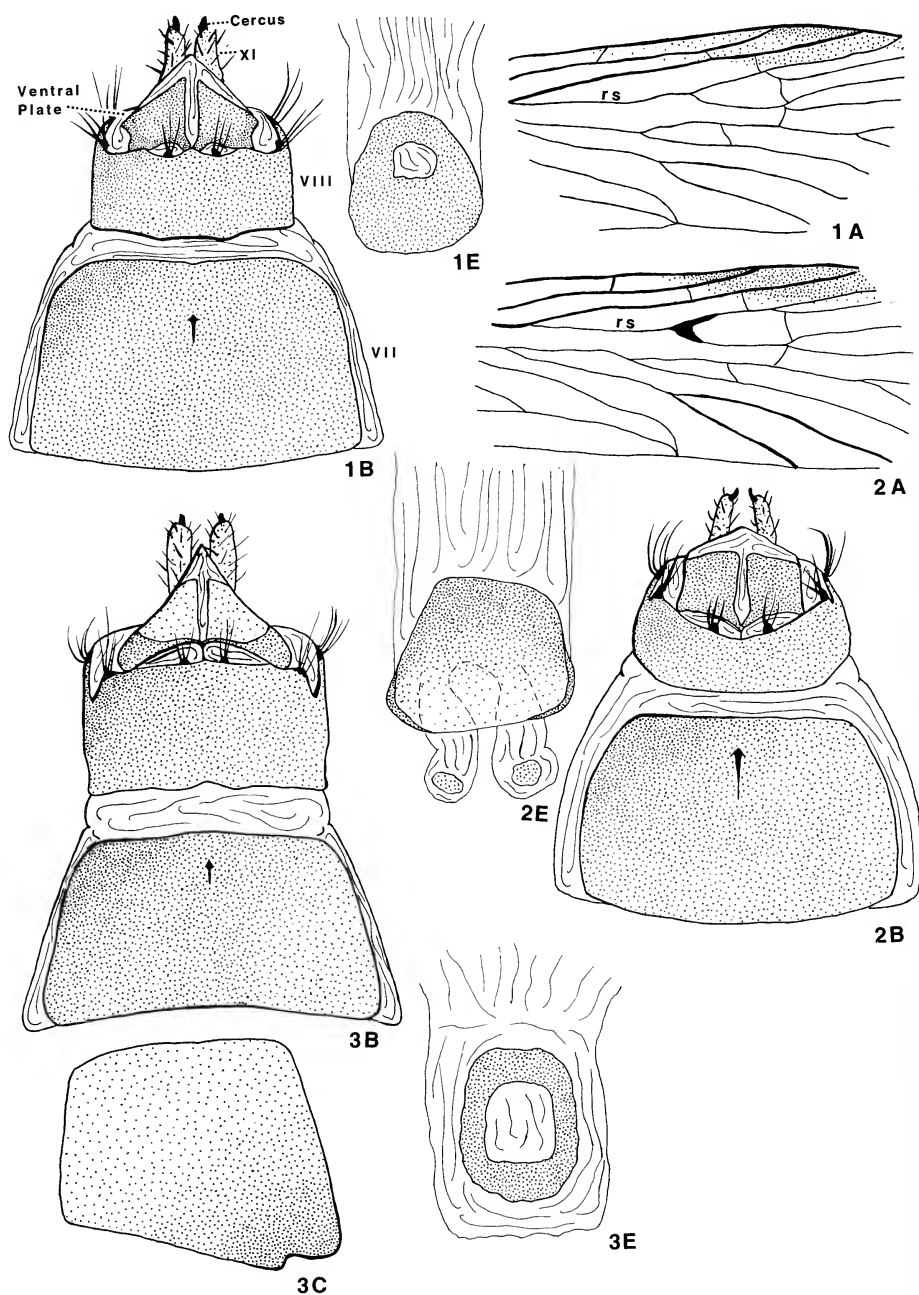
Chimarra aterrima Hagen, 1861

Figs. 1A, B, E

Diagnosis of Female. Most closely resembling females of *C. augusta* Morse. However, the first fork of the radial sector (rs) vein of the forewing is not at all thickened (Fig. 1A). Also, the spermathecal sclerite in ventral view (Fig. 1E) has a conspicuous central opening, the sclerite appearing nearly circular and without anterolateral protrusions.

Description of Female. In addition to characters mentioned in diagnosis, body dark brown; sternum VIII with two pairs of setose spots posteroventrally; membrane between sternum VIII and ventral plates transverse and separated from longitudinal membrane between ventral plates by slender sclerotized strip connecting anteromesal corners of plates with each other; ventral plates with little differential sclerotization, occasionally slightly darker anteriorly and laterally; ventral plates appearing distinctly quadrangular—transverse anteriorly, oblique posteriorly, longitudinal mesally and laterally, long mesal margins more or less parallel with each other and with short lateral margins (Fig. 1B); tergum X with lateral margins straight in dorsal view.

Material Examined. USA, **Georgia:** Crawford County, Camp Eunice, approx. 8 km (5 mi) SSE. of Roberta, Spring Creek below pond, UV light, 5 Jun 1981, Hamilton and Rothschild, 1 ♀ (CUAC). **Louisiana:** Jackson Parish, Schoolhouse Spring, 25 May 1997, Morse, 10 ♀ (CUAC). **South Carolina:** Aiken County, Savannah River Plant, Upper Three Runs Creek at SRP Rd. 8-1, 12–13 Apr 1979, McEwan and Powell, 1 ♂ 1 ♀ (CUAC); Savannah River Site, Upper Three Runs Creek approx.



Figs. 1-3. Characters of females of *Chimarra* species. 1, *C. aterrima*; 2, *C. augusta*; 3, *C. falculata*; A = middle section of right forewing, dorsal view; B = abdominal segments VII-XI, ventral view; E = genital chamber and spermathecal sclerite, ventral view.

2 km downstream of SC 125, 12 Jul 1990, Floyd, 1 ♀; also, 27 Jul 1990, 1 ♀; 24 Aug 1990, 1 ♀; 7 Sep 1989, 4 ♀; 20 Sep 1990, 1 ♀ (all CUAC); Savannah River Site, Upper Three Runs Creek at Road C bridge crossing, 12 Jul 1990, Floyd, 1 ♂, 1 ♀; also, 27 Jul 1990, 1 ♀; 7 Sep 1989, 2 ♀ (all CUAC); Greenville County, Brushy Creek just upstream of confluence with N. Saluda (Poinsett) Reservoir, off Rte. 969, Greenville Watershed property, 15 Jun 1992, Floyd, Morse, and Woodring, 1 ♀ (CUAC); Oconee County, W. trib. Burgess Creek, 0.5 km from Hwy 130, 34.93N, 83.00W, black light, 14 Apr 1995, Prather and Miller, 1 ♀ (CUAC); Pickens County, Clemson University Experimental Forest, Lake Issaqueena, 18 Apr 1991, Mitchell, 1 ♀ (CUAC); Clemson University Experimental Forest, W. trib. Sixmile Creek, el. 227 ♂ (740 ft), 5–12 Apr 1988, Malaise Trap, Hoffman, 19 ♂, 60 ♀; also, 12–19 Apr 1988, 24 ♂, 54 ♀; 19–24 Apr 1988, 7 ♂, 19 ♀; 24 Apr–4 May 1988, 4 ♂, 5 ♀; 8–15 May 1988, 1 ♂, 1 ♀; 12–20 Jun 1988, 8 ♀ (all CUAC); Clemson University Experimental Forest around Lake Issaqueena, Wildcat Creek, el. 236 ♂ (770 ft), 4–12 Apr 1988, Hoffman, Malaise Trap, 1 ♀; also, 12–19 Apr 1988, 3 ♂, 4 ♀; 24 Apr–4 May 1988, 1 ♂, 4 ♀; 12–20 Jun 1988, 1 ♀ (all CUAC).

Distribution. Eastern North America; Canada: MB, NB, NF, NS, ON, PQ; United States of America: AL, AR, CT, DC, DE, FL, GA, IL, IN, KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, NH, NJ, NY, OH, OK, PA, SC, TN, TX, VA, VT, WI, WV.

Chimarra augusta Morse, 1971

Figs. 2A, B, E

Diagnosis of Female. Most closely resembling *C. aterrima*. However, the first fork of the radial sector (rs) vein in the forewing is thickened (Fig. 2A). Also, the spermathecal sclerite, from ventral view (Fig. 2E), appears complete, lacking a conspicuous opening and having a pair of sclerite-bearing semi-membranous protrusions anterodorsally.

Description of Female. In addition to characters mentioned in diagnosis, body dark orange to tan; sternum VIII with two pairs of setose spots posteroventrally; membrane between sternum VIII and ventral plates transverse, membrane between ventral plates longitudinal, these two membranous regions separated by contiguous anteromesal corners of ventral plates; ventral plates with no differential sclerotization, appearing quadrangular, transverse apically (Fig. 2B).

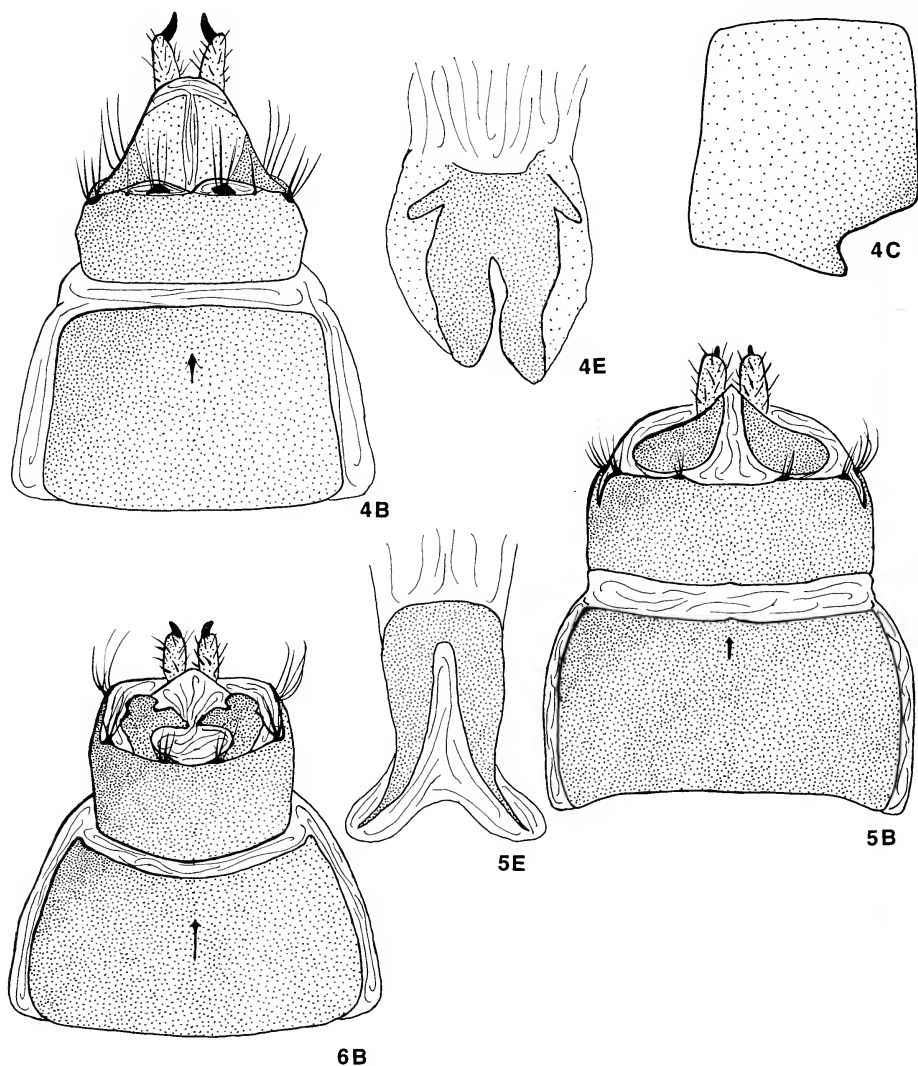
Material Examined. USA, **South Carolina:** Barnwell County, Savannah River Plant, Lower Three Runs Creek at SRP Rds. 8 and 8-8, el. 145 ♂ (400 ft), 29 May 1984, Morse, 1 ♀ (CUAC); Oconee County, Brasstown, Devil's Hole Creek, UV light, 19 Jul 1969, Douglass, 3 ♂, 7 ♀ (CUAC).

Distribution. Southern Appalachian Mountains. United States of America: AL, SC, TN, VA, WV.

Chimarra feria Ross, 1941

Figs. 4B, C, E

Diagnosis of Female. Most similar to *C. holzenthali* Lago and Harris. However, the female of this species is distinguishable by the comparatively small ventromesal projection of sternum VII, approximately 1/3 as tall as long in profile (Fig. 4C) and by the ring-like appearance of the spermathecal sclerite from ventral view (Fig. 4E).



Figs. 4-6. Characters of females of *Chimarra* species. 4, *C. feria*; 5, *C. florida*; 6, *C. holzenthali*; B = abdominal segments VII-XI, ventral view; C = abdominal sternum VII, left lateral view; E = genital chamber and spermathecal sclerite, ventral view.

Description of Female. In addition to diagnostic characters above, body color dark brown, sternum VIII with two pairs of posteroventral setose spots; transverse membrane between sternum VIII and ventral plates separated from longitudinal membrane between plates by contiguous anteromesal corners of plates; ventral plates more darkly sclerotized anteriorly, plates thus appearing transverse, mesal margins nearly parallel (Fig. 4B); lateral margins of tergum X straight in dorsal view.

Material Examined: Canada, **Ontario:** Jock's Creek, 10 mi. S. Ottawa, 24 May

1964, Ricker, 3 ♂, 1 ♀ (INHS); Peal Creek, TLH, Peal T. Bay, 9 Jul 1980, Nimmo, 2 ♀ (UMS). **Quebec:** Hull, Gatineau Park, Creek below beaver dam, 31 May 1964, Ricker, 1 ♂, 1 ♀ (INHS). **USA, Arkansas:** Montgomery County, L. Missouri River - Albert Pike, LM-3S, 19 Sep 1980, EJ Bacon, 1 ♀; also, 20 Sep 1980, 19 ♀ (all CUAC). **Illinois:** [County ?], Herod, May 1946, Ross and Mohr, 14 ♂, 1 ♀ (INHS); [County ?], Eddyville, Lusk Creek, 16-17 May 1947, Burks, 6 ♂, 1 ♀ (INHS); [Lee County ?], Dixon Springs, 30 Aug 1951, Ross and Richards, 4 ♂, 2 ♀ (INHS); Pope County—Bell Smith Springs, 29 Apr 1949, Sanderson and Stannard, 4 ♂, 3 ♀ (INHS); Bell Smith Springs, along stream, 4 May 1950, Sanderson and Stannard, 1 ♂, 1 ♀ (INHS). **Oklahoma:** [McCurain County], Broken Bow, 8 Jun 1940, Mrs. Roy Weddle, 1 ♂, 1 ♀ (INHS).

Distribution. Great Lakes region and Mississippi Valley; Canada: ON, PQ, NF; United States of America: AL, AR, IL, IN, KS, KY, MI, MN, MO, MS, NE, OK, TX, WI.

Chimarra holzenthali Lago and Harris, 1987

Figs. 6B, C, E

Diagnosis of Female. Closely resembling *C. feria*. However, females are distinguished by the rather large ventromesal projection of sternum VII, two-thirds as tall as long (Fig. 6C) and by the forked spermathecal sclerite (Fig. 6E).

Description of Female. In addition to characters mentioned in diagnosis, body and wings golden brown; sternum VIII frequently with three pairs of setose spots; transverse membrane between sternum VIII and ventral plates separated from longitudinal membrane between plates by anteromesal corners of plates nearly touching; triangular anterolateral areas of ventral plates more darkly sclerotized, with lightly sclerotized, inconspicuous parts of plates extending toward meson, separated by longitudinal, nearly parallel-sided membrane (Fig. 6B); tergum X with lateral margins straight in dorsal view; cerci large, 2/3 as long as segment XI.

Material Examined. **USA, Louisiana:** Jackson Parish, Schoolhouse Springs near Indian Village, 30 Mar 1973, Morse and Louton, 3 ♀ paratypes (CUAC); also, "28 Apr or 28 Jul 1973," Morse, Louton, and Dunn, 2 ♀ paratypes (CUAC); 24 Aug 1973, Morse and Louton, 2 ♀ paratypes (UMS); 4 Sep 1973, Dunn, Smith, and Louton, 1 ♂, 1 ♀ paratypes (UMS).

Distribution. Southcentral North America; United States of America: LA, TX (Bowles, et al. 1993).

Chimarra obscura Complex Lago and Harris, 1987

A diagnostic character for males of this Complex not mentioned by Lago and Harris (1987) is that the claws of the foretarsi are unusually large. The claws of the females are of normal small size.

Chimarra falculata Lago and Harris, 1987

Figs. 3B, E

Diagnosis of Female. Markedly dissimilar from other eastern North American species, this species resembles *C. holzenthali* in the forked condition of the spermathecal

sclerite. However, the anterior ends of the forked spermathecal sclerite are acute in *C. falculata* (Fig. 6E) and the ventral plates are tear-drop shaped (Fig. 3B).

Description of Female. In addition to characters mentioned in diagnosis, body, wings, and most appendages medium reddish brown, hind tibiae tan but their spurs medium brown; two pairs of setose spots posteroventrally on sternum VIII; ventral plates without differential sclerotization; membrane between plates wide anteriorly, narrowing posteriorly, continuous with membrane between sternum VIII and ventral plates (Fig. 3B); lateral margins of tergum X straight in dorsal view.

Material Examined. USA, **Florida:** Okaloosa County, Eglin Air Force Base, Turkey Gobbler Creek at Road 211 W. of Hwy. 85, 15 Aug 1985, Armitage, 2 ♀ (CLAU); Eglin Air Force Base, Juniper Creek at Road 221 E. of Hwy 85, 15 Aug 1985, Armitage, 6 ♀ (CLAU); Eglin Air Force Base, Malone Creek at Road 211 W. of Hwy. 85, 15 Aug 1985, Armitage, 2 ♀ (CLAU).

Distribution. Southeastern Coastal Plain; United States of America: AL, FL, GA, MS.

Chimarra florida Ross, 1944

Fig. 5B

Diagnosis of Female. The female of this species is very similar to that of *C. obscura*. However, the membrane between the ventral plates is transversely oval (Fig. 5B) and the ventral plates each have a rounded posterolateral projection.

Description of Female. In addition to characters mentioned in diagnosis, body, wings, and appendages medium to dark reddish brown; sternum VIII with two pairs of posteroventral setose spots; ventral plates with little or no differential sclerotization; membrane between ventral plates constricted where plates extend inward subapically (Fig. 5B); tergum X with lateral margin straight in dorsal view.

Material Examined. USA, **Georgia:** Crawford County, 8 km (5 mi) SSE. of Roberta, Spring Creek above pond at Camp Eunice main site, 7 May 1982, 30 Jun 1983, 8 and 29 Sep 1983, UV light, Hamilton and Holzenthal, 3 m, 17 ♀ (all CUAC); 5 mi. SSE. of Roberta, Spring Creek at old log bridge, UV light, 27 May, 10 and 30 Jun, 4 and 25 Aug, 20 Oct in 1983, Hamilton and Holzenthal, 25 m, 30 ♀ (all CUAC); 8 km (5 mi) SSE. of Roberta, Spring Creek below pond and Camp Eunice, UV light, 5 Jun 1981, Hamilton and Rothschild, 7 ♀ (CUAC); 8 km (5 mi) SSE. of Roberta, Spring Creek at US 341, 11 May, 10 and 30 Jun 1983, UV light, Hamilton and Holzenthal, 2 ♂, 8 ♀ (all CUAC). **Louisiana:** St. Tammany Parish, Talisheek, 4 Jun 1973, Morse and Louton, 1 ♂, 6 ♀ (CUAC). **South Carolina:** Aiken County, Savannah River Plant, Upper Three Runs Creek at SRP Rd. 8-1, 29 Mar, 12-13 Apr, 3 and 10-11 and 17 and 18 and 23-24 and 28 May, 1 and 13 and 26 and 28 Jun, 1 and 29 Jul, 6-8 and 22 Aug, 1 and 4 and 18-19 Sep, 12-13 Oct in 1976, 1977, 1979, and 1984, Morse, Kelly, McEwan, Powell, Herlong, and Prichard, 125 ♂ and 654 ♀ (all CUAC); Savannah River Site, Upper Three Runs Creek at Road C bridge crossing, 11 and 18 Apr, 18 May, 6 and 26 Jun, 12 and 27 Jul, 10 and 24 Aug, 6 and 7 and 20 Sep, 4 Oct in 1989 and 1990, Floyd, 22 ♂, 166 ♀ (all CUAC); Savannah River Plant, Upper Three Runs Creek, approx. 2 km downstream of SC 125, 8 May, 27 Jul, 10 and 24 Aug, 6 and 7 Sep in 1989 and 1990, Floyd, 74 ♀ (all CUAC); Savannah River Plant, Upper Three Runs Creek at SRP Road "F", 28 Jun 1977, Herlong and Prichard, 5 ♀ (CUAC); Savannah River Plant, Tinker Creek

at SRP Rd. 8-1, 18-19 Sep 1976, Herlong and Prichard, 1 ♀ (CUAC); Aiken State Park, Fish Lake outlet, 2-3 Jun 1981, CU Ent 412/612 class, 4 ♀ (CUAC); Aiken State Park, 13-14 Jun 1980, Lay, 1 ♀ (CUAC); Jackson, Hollow Creek at SC 125, 3 May 1988, Hoffman and Spooner, 24 ♀ (CUAC). Barnwell County, Savannah River Plant, Lower Three Runs Creek near SRP Rds. 8 and 8-8, 11-12 Jun and 20-21 Aug 1979, Kelley and McEwan, 2 ♀ (all CUAC).

Distribution. Southeastern Coastal Plain; United States of America: AL, FL, GA, LA, MS, NJ, SC.

Chimarra moselyi Denning, 1947

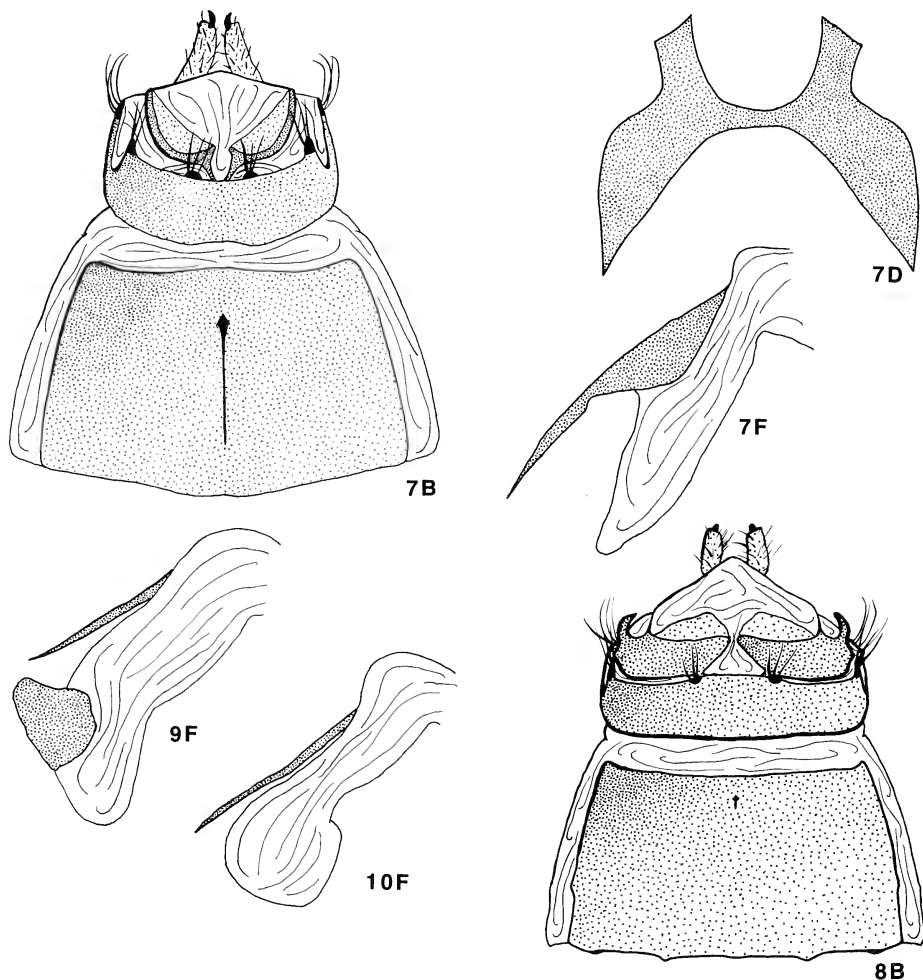
Figs. 7B, D, F

Diagnosis of Female. The female of this species is very similar to females of *C. socia* and *C. parasocia*. Tergum X is conspicuously constricted subapically in dorsal view (Fig. 7D, also Ross 1944, fig. 185C) in these three species. However, the spermathecal sclerite from lateral view is wide posteriorly and diverging about 20°-25° from the ventral membranes (Fig. 7F). Forewings each 5.5-6.8 mm.

Description of Female. In addition to characters mentioned in diagnosis, body and wings and tibial spurs medium brown, legs (but not spurs) and basal segment of each labial palp light brown or tan; ventromesal projection on abdominal sternum VII usually more than half as long as sternum VII (projection represented as longitudinal mesal line in Fig. 7B); abdominal sternum VIII with two pairs of posterior-ventral setose spots; membrane between sternum VIII and ventral plates transverse and separated from membrane between plates by contiguous anteromesal corners of plates; ventral plates with strongly sclerotized curved line along anterior and lateral edges.

Material Examined. USA, **South Carolina:** Aiken County, Savannah River Plant, Upper Three Runs Creek at SRP Rd. 8-1, lt. trap, 24 and 28 May, 1 and 29 Jul, 4 Sep 1984, Morse, 525 ♀ (CUAC); also, 23-24 Jul 1979, lt. trap, McEwan and Powell, 1 ♀ (CUAC); Savannah River Site, Upper Three Runs Creek approx. 2 km downstream of SC 125, 18 Apr, 8 and 18 May, 6 and 26 Jun, 12 and 27 Jul, 10 and 24 Aug, 20 Sep, 4 Oct 1990, Floyd, 24 m, 68 ♀ (CUAC); Savannah River Site, Upper Three Runs Creek at Road C bridge crossing, 18 Apr, 8 and 18 May, 6 and 26 Jun, 12 and 27 Jul, 10 and 24 Aug, 20 Sep, 4 Oct 1990 and 1991, Floyd, 1 ♂, 50 ♀ (CUAC). Barnwell County, Savannah River Site, Lower Three Runs Creek at SRS Rds. 8 and 8-8, 29 May and 30 Jul 1984, Morse, 3 ♂, 24 ♀ (CUAC). **Georgia:** Appling/Toombs Counties line, Altamaha River at US Rte. 1, 8-10 Apr 1974, Sherberger and Hager, 19 ♀ (CUAC). Crawford County, approx. 8 km (5 mi) SSE. of Roberta, Spring Creek at US 341, 27 May 1983, Holzenthal and Hamilton, 1 ♀ (CUAC).

Distribution. Ohio River valley and lower elevations in southeastern North America; United States of America: AL, FL, GA, IL, IN, KY, LA, MO, MS, NC, OH, SC, TN, VA.



Figs. 7–10. Characters of females of *Chimarra* species. 7, *C. moselyi*; 8, *C. obscura*; 9, *C. parasocia*; 10, *C. socia*; B = abdominal segments VII–XI, ventral view; D = tergum X, dorsal view; F = genital chamber and spermathecal sclerite, left lateral view.

Chimarra obscura Walker, 1852

Fig. 8B

Diagnosis of Female. The female of this species most closely resembles that of *C. florida* in the anterior separation between the ventral plates and the presence of posterior projections from those plates. However, the posterior projections of the ventral plates are acute and more nearly lateral in this species and are especially prominent in profile from ventral view (Fig. 8B). Furthermore, the anterior membranes between the ventral plates form a conspicuous isosceles triangle.

Description of Female. In addition to characters of diagnosis, head, thorax, wings,

and appendages dark brown, abdomen medium reddish brown; sternum VIII fairly short, approximately $1/3$ as long as sternum VII, and with two pairs of posteroventral setose spots; ventral plates conspicuously differentially sclerotized and with mesal margins nearly touching at mid-length, longitudinal membrane separating plates resembling hourglass; spermathecal sclerite U-shaped in ventral view (Ross 1944, fig. 184B).

Material Examined. USA, **Arkansas:** Montgomery County, L. Missouri River - Albert Pike, LM-3S, 19 and 20 Sep 1980, EJ Bacon, 32 ♀ (CUAC). **Georgia/South Carolina:** Rabun/Oconee Counties line, Chatooga River at Rte. 28, 34°55'N, 83°10'W, 28 Jun 1991, Floyd and Nichol, 2 m, 19 ♀ (CUAC). **South Carolina:** Aiken County, Savannah River Plant, Upper Three Runs Creek at SRP Rd. 8-1, 1 Sep 1979, Lt. Trap, Kelley and McEwan, 1 ♀ (CUAC); also, 28 May 1984, Morse, 3 ♀ (CUAC); Savannah River Site, Upper Three Runs Creek, approx. 2 km downstream of SC 125, 18 Apr, 8 May, 6 and 26 Jun, 27 Jul, 10 and 24 Aug, 6 and 7 and 20 Sep, 4 Oct 1989 and 1990, Floyd, 2 ♂, 83 ♀ (all CUAC); Savannah River Site, Upper Three Runs Creek at Road C bridge crossing, 11 Apr, 6 Jun, 12 and 27 Jul, 10 and 24 Aug, 6 and 7 and 20 Sep, 4 Oct 1989 and 1990 and 1991, Floyd, 3 ♂, 87 ♀ (all CUAC); Jackson, Hollow Creek at SC 125, 3 May 1988, Hoffman and Spooner, 5 ♀ (CUAC). Barnwell County, Savannah River Site, Lower Three Runs Creek near SRS Rds. 8 and 8-8, 14-15 Sep 1979, Kelley and McEwan, 1 ♀ (CUAC); Greenville County—Greenville Watershed property, Slicking Creek at confluence with Table Rock Reservoir, 29 Jun 1992, Floyd and Woodring, 1 ♂, 3 ♀ (CUAC); Greenville Watershed property, S. Saluda River at confluence with Table Rock Reservoir, 29 Jun 1992, Floyd and Woodring, 2 ♀ (CUAC). Pickens County, Clemson University Experimental Forest, Wildcat Creek, el. 237 ♂ (770 ft), UV light, 21 May 1988, Hoffman, 1 ♀ (CUAC).

Distribution. Eastern North America except South Atlantic Coastal Plain; Canada: LB, MB, NE, NS, ON, PQ; United States of America: AL, AR, CT, DE, FL, IL, IN, KS, KY, MA, MD, ME, MI, MN, MO, MS, NE, NH, NJ, NY, OH, OK, PA, SC, TN, TX, VA, VT, WI.

Chimarra parasocia Lago and Harris, 1987

Fig. 9F

Diagnosis of Female. Very similar to the females of *C. moselyi* and *C. socia*. However, the ventral membranes of the spermatheca have a sclerite that is conspicuous in lateral view (Fig. 9F) and the forewing length is only about 5.0 mm.

Description of Female. Head, thorax, antennae light reddish brown, wings light brown, legs and palps tan; ventromesal projection of sternum VII short, less than half as long as sternum VII; sternum VIII with two pairs of setose spots posteroventrally; membrane between sternum VIII and ventral plates transverse, separated from median membrane by contiguous anteromedial corners of ventral plates; ventral plates each with strongly sclerotized line anteriorly and laterally (as in Fig. 7B); plates divergent, with mesal margins separating posterally; tergum X conspicuously constricted subapically in dorsal view (as in Fig. 7D).

Material Examined. USA, **Arkansas:** Montgomery County, L. Missouri River - Albert Pike, LM-3S, 19 and 20 Sep 1980, EJ Bacon, 47 ♀ (CUAC). **Mississippi:**

Simpson County, 3.7 km (2.3 mi) W of Pinola, upstream of Hwy. 28, 20 Jun 1979, Holzenthal, 8 ♀ (CUAC). Wilkinson County, Buff River at Hwy 61, 24 Jun 1982, Lago, 5 ♀ (UMS).

Distribution. Eastern Texas and southern Mississippi River Valley to western edge of southern Appalachian Mountains; United States of America: AL, AR, KY, LA, MO, MS, TN, TX (Bowles et al. 1993).

Chimarra socia Hagen, 1861

Fig. 10F

Diagnosis of Female: The female of *C. socia* is very similar to the females of *C. parasocia* and *C. moselyi*. However, the ventral membranes of the spermatheca are not sclerotized (Fig. 10F) and the forewing is about 5.5–6.0 mm long.

Description of Female. Head, thorax, wings, and antennae ranging from light brown to near black, palps and legs lighter, except dark spurs; ventromesal projection of sternum VII short, less than half as long as sternum VII; sternum VIII with two pairs of posteroventral setose spots; membrane between sternum VIII and ventral plates transverse, separated from median membrane by contiguous anteromedial corners of ventral plates; ventral plates each with strongly sclerotized line anteriorly and laterally (as in Fig. 7B); plates divergent, with mesal margins separating posteriorly; tergum X conspicuously constricted subapically in dorsal view (as in Fig. 7D; Ross 1944, fig. 185C).

Specimens from the Southern Appalachian Mountains are dark brown, differing from those of the more northern regions of North America, suggesting a genetic difference. However, sufficient material was not available and no other morphological distinctions were found to support this hypothesis.

Most likely, the female described by Ross (1944) as *C. socia* actually was that of *C. moselyi*, first recognized as a separate species in 1947. No *C. socia* specimens have been found in Illinois since Ross' report and his description fits both *C. moselyi* and *C. socia*.

Material Examined. CANADA, **Quebec:** Montreal, 27 Aug 1947, Burks, 7 ♀ (UMS). USA, **Georgia/South Carolina:** Rabun/Oconee Counties, Chattooga River at SC Rte. 28, 34°55'N, 83°10'W, 28 Jun 1991, Floyd and Nichol, 208 ♀ Coleman It., 6 Jul 1969, PH Carlson, 1 ♂, 5 ♀; 16 and 21 Aug 1969, UV light, Morse, 27 ♂, 20 ♀ (all CUAC).

Distribution. Great Lakes region and northeastern North America and Appalachian Mountains; Canada: LB, MB, NB, NF, NS, ON, PQ; United States of America: CT, DC, GA (record confirmed herein), MA, MD, ME, MI, MN, NC, NH, NJ, NY, PA, SC (record confirmed herein), VA, WI, WV.

KEY TO FEMALES OF THE EASTERN NORTH AMERICAN *CHIMARRA* SPECIES

1. Ventral plates each with prominent lateral extension especially visible in profile from ventral view (Fig. 8B); anterior membranes between plates distinctly triangular (Fig. 8B) *Chimarra obscura* Walker.
- 1'. Ventral plates with lateral extensions not as prominent (Fig. 5B) or absent (Fig. 3B) 2
- 2(1'). Membranes between ventral plates transversely oval (Fig. 5B); ventral plates each with rounded posterolateral projection or extension (Fig. 5B) *Chimarra florida* Ross.

- 2'. Membranes between ventral plates longitudinally oval (Fig. 7B), linear (Figs. 1B, 4B), or narrower posteriorly (Fig. 3B); ventral plates without posterolateral extensions (Fig. 1B) 3
- 3(2'). Ventral plates tear-drop shaped (Fig. 3B); spermathecal sclerite forked and acute anteriorly (Fig. 3E) *Chimarra falculata* Lago and Harris.
- 3'. Ventral plates linear (Fig. 7B), rectangular (Fig. 2B), triangular (Fig. 6B), or transverse (Fig. 4B); spermathecal sclerite not forked (Fig. 1E) or blunt anteriorly (Fig. 6E) 4
- 4(3'). Ventral plates with strongly sclerotized, curved line anterolaterally and with mesal margins diverging posteriorly (Fig. 7B); tergum X margins constricted subapically in dorsal view (Fig. 7D) 5
- 4'. Ventral plates only slightly more sclerotized anterolaterally and with mesal margins parallel (Figs. 1B, 4B, 6B) or plates not differentially sclerotized (Fig. 2B); tergum X margins straight, not constricted 7
- 5(4). Spermathecal sclerite wide posteriorly in lateral view and diverging about 20°–25° from ventral membranes (Fig. 7F) *Chimarra moselyi* Denning.
- 5'. Spermathecal sclerite thin posteriorly in lateral view and diverging only about 15° or less from ventral membranes (Fig. 9F) 6
- 6(5'). Ventral membranes of genital chamber with apical sclerite conspicuous in lateral view (Fig. 9F); forewing about 5.0 mm long . . . *Chimarra parasocia* Lago and Harris.
- 6'. Ventral membranes of genital chamber without apical sclerite (Fig. 10F); forewing 5.5–6.0 mm long *Chimarra socia* Hagen.
- 7(4'). Ventral plates with little (Fig. 1B) or no (Fig. 2B) differential sclerotization, such that plates conspicuously quadrangular 8
- 7'. Ventral plates distinctly more darkly sclerotized anterolaterally, such that plates appearing transverse (Fig. 4B) or triangular (Fig. 6B) 9
- 8(7). Forewings each with first fork of radial sector (rs) thickened (Fig. 2A); spermathecal sclerite without conspicuous opening in ventral view and with pair of sclerite-bearing semimembranous protrusions anterodorsally (Fig. 2E); body usually light tan to dark orange *Chimarra augusta* Morse.
- 8'. Forewing with no forks thickened (Fig. 1A); spermathecal sclerite with conspicuous central opening and without anterodorsal protrusions (Fig. 1E); body dark brown *Chimarra aterrima* Hagen.
- 9(7'). Spermathecal sclerite ring-like in ventral view (Fig. 4E); sternum VII with ventromesal projection 1/3 as tall as long (Fig. 4C); sternum VIII never with more than two pairs of posteroventral setose spots (Fig. 4B); body dark brown
- *Chimarra feria* Ross.
- 9'. Spermathecal sclerite forked (Fig. 6E); sternum VII with ventromesal projection 2/3 as tall as long (Fig. 6C); sternum VIII frequently with three pairs of posterior setose spots (Fig. 6B); body light tan to dark orange
- *Chimarra holzenthali* Lago and Harris.

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Dr. Paul K. Lago (University of Mississippi), Dr. Steven C. Harris (Clarion University), and Ms. Kathleen Reid Zeiders (Illinois Natural History Survey) kindly loaned specimens for use in this investigation. Dr. Lago, Dr. Harris, Dr. Roger J. Blahnik (Rutgers University), and Dr. Cynthia R.L. Adler (Clemson University) provided useful suggestions for improving the text. Dr. William C. Alexander (SC Governor's School for Science and Mathematics—SC GSSM) was instrumental in his encouragement and review of the manuscript. Dr. Katherine Kellam coordinated the South Carolina High School Summer Research Program which administered

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LITERATURE CITED

- Armitage, B. J. 1983. Diagnostic atlas of the North American caddisfly adults, I: Philopotamidae. The Caddis Press, Ohio Biological Survey.
- Armitage, B. J. 1991. Diagnostic atlas of the North American caddisfly adults, I: Philopotamidae, 2nd edition. The Caddis Press, Ohio Biological Survey.
- Bowles, D. E., O. S. Flint, Jr. and S. R. Moulton, II. 1993. Records of *Chimarra holzenthali* and *C. parasocia* (Trichoptera: Philopotamidae) from eastern Texas. Entomol. News 104: 263–264.
- Lago, P. K. and S. C. Harris. 1987. The *Chimarra* (Trichoptera: Philopotamidae) of eastern North America with descriptions of three new species. J. New York Entomol. Soc. 95: 225–251.
- Merritt, R. W. and K. W. Cummins, editors. 1996. An introduction to the aquatic insects of North America, 3rd edition. Kendall/Hunt Publishing Company, Dubuque, Iowa.
- Milne, M. J. 1938. The “metamorphotype method” in Trichoptera. J. New York Entomol. Soc. 46:435–437.
- Nielsen, A. 1980. A comparative study of the genital segments and the genital chamber in female Trichoptera. Det Kongelige Danske Videnskabskabernes Selskab, Biologiske Skrifter 23(1):1–200.
- Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. Bulletin of the Illinois Natural History Survey 23(1):1–326.
- Schmid, F. 1980. Les insectes et arachnides du Canada, partie 7: genera des trichoptères du Canada et des États adjacents. Agriculture Canada 1692:1–296.
- Wiggins, G. B. 1996. Larvae of the North American caddisfly genera (Trichoptera), 2nd edition. University of Toronto Press, Toronto.

**FIRST RECORD OF THE GENUS *RIBAUTIELLA* BROLEMANN
IN THE WESTERN HEMISPHERE AND A KEY TO THE
SPECIES OF THE WORLD
(SYMPHYLA: SCOLOPENDRELLIDAE)**

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Abstract.—The genus *Ribautiella* (Symphyla: Scolopendrellidae), previously known from Africa and Madagascar, is reported for the first time from the Western Hemisphere. A new species *R. tuxeni* is described from Taperinha, Brazil. A key to the six known species is given.

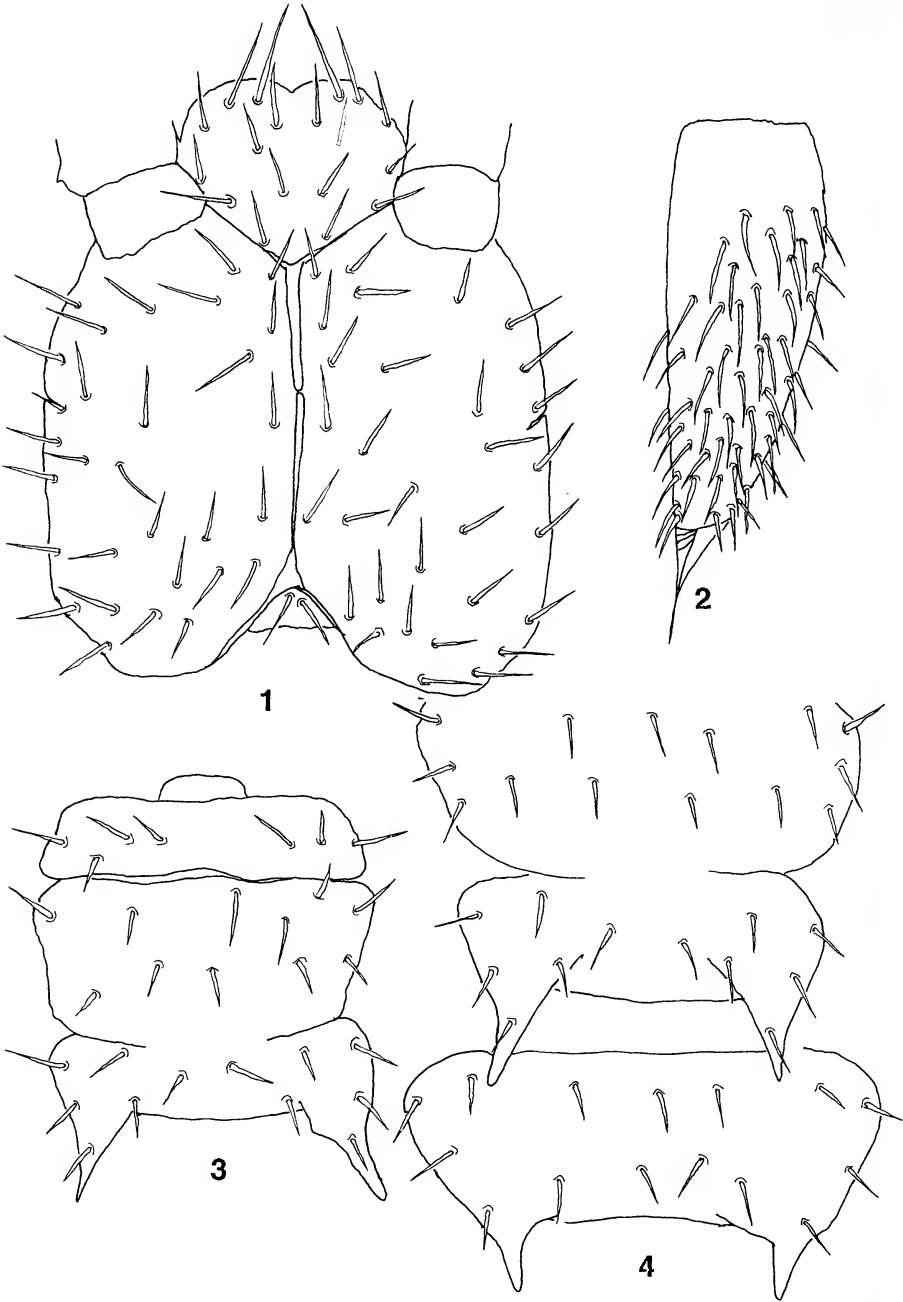
The genus *Ribautiella* was described by Brolemann (1926) for a symphylid species from the tropical regions of Africa, *R. zagnanadina*. The genus is characterized by having 23–24 dorsal sclerites, more than any other symphylid genus, and a vestigial first pair of legs. It was not until 1954 that additional species were described and placed in the genus: *R. borbonica* Jupeau (Madagascar); *R. machadoi* Henschberger and *R. schoutedeni* Henschberger (Angola). In 1956 Rochaix added a fifth species, *R. delphini*, based on specimens from Madagascar. Thus, the known geographical range of the genus has been confined to the tropical regions of Africa.

During an examination of several hundred specimens loaned to me by Dr. H. Enghoff of the Zoological Museum, Copenhagen, five specimens belonging to the genus *Ribautiella* from Brazil were found, extending the known range of the genus to the Western Hemisphere. Four of the specimens from Brazil were immatures having only 11 leg pairs but one specimen was a 12 leg pair adult. Previously Jupeau (1962) had recorded only three symphylid species from Brazil (*Symphylellopsis brasiliensis* Jupeau, *Hanseniella unguiculata* (Hansen), *H. longisetis* Jupeau). The species *S. brasiliensis*, described by Jupeau (1962) superficially resembles the new species of *Ribautiella* described in this paper.

Using the descriptions and illustrations provided by previous authors, it is possible to construct a key that will aid other workers in identifying these interesting species of Symphyla.

KEY TO THE SPECIES OF RIBAUTIELLA

- 1. At least 1 seta on the triangular portion of scuta 2 and 3 towards the apex (Figs. 3, 4, 9) 2
- Seta absent on the triangular portion of scuta 2 and 3 towards the apex (Figs. 6, 15, 16) 5
- 2. Cerci densely setose (Fig. 2); setae on head relatively long (Fig. 1) *R. zagnanadina*
- Cerci sparsely setose (Figs. 32, 33); setae on head relatively short (Figs. 5, 10) 3
- 3. Scuta 2 distinctly divided into a basal and apical portion; basal portion relatively large (Figs. 6, 15 as examples); apical portion with 11 setae; cerci with apex not extended, with only 2 striations *R. machadol*



Figs. 1-4. *Ribautiella zabnanadina* Brolemann. 1. Head, dorsal. 2. Cerci, dorsal. 3. Scuta 3-4 (Redrawn from Hinschberger 1954).

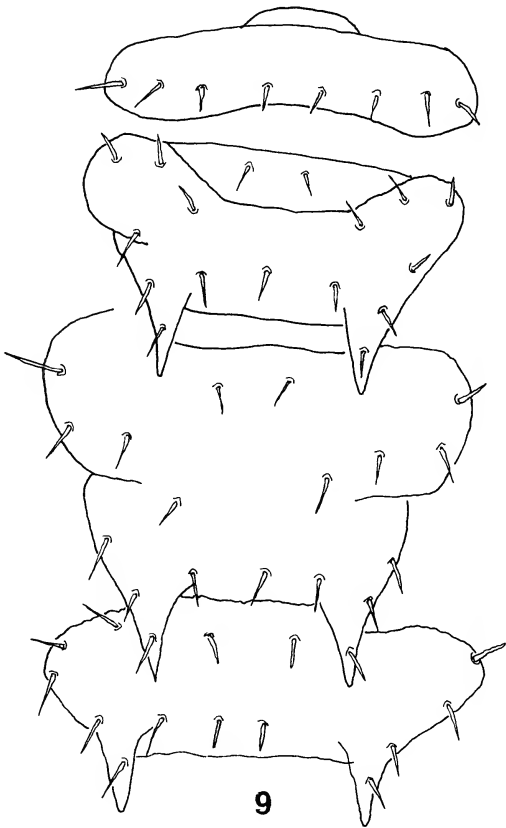
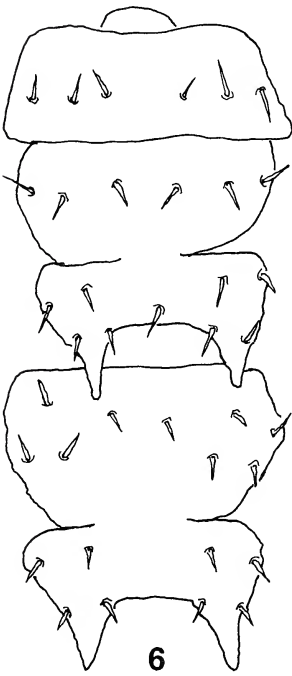
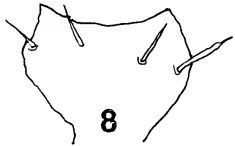
- Division of scuta 2 into basal and apical parts obscure (Fig. 9); basal portion relatively small; cerci with the apex distinctly extended, with at least 4 striations 4
- 4. Apex of cerci with numerous striations; antennae 16–17 segmented *R. borbonica*
- Apex of cerci with 4–5 striations; antennae, 14 segmented *R. delphini*
- 5. Distal antennal segments with numerous sensory organs along the apical margin of each segment (Fig. 7); scuta wide; apical portion of central rod of head distinct (Fig. 5) *R. schoutedeni*
- Distal antennal segments with few sensory organs along the apical margin (Fig. 13); scuta 1 narrow (Fig. 14); apical portion of central rod of head absent *R. tuxeni*, new species

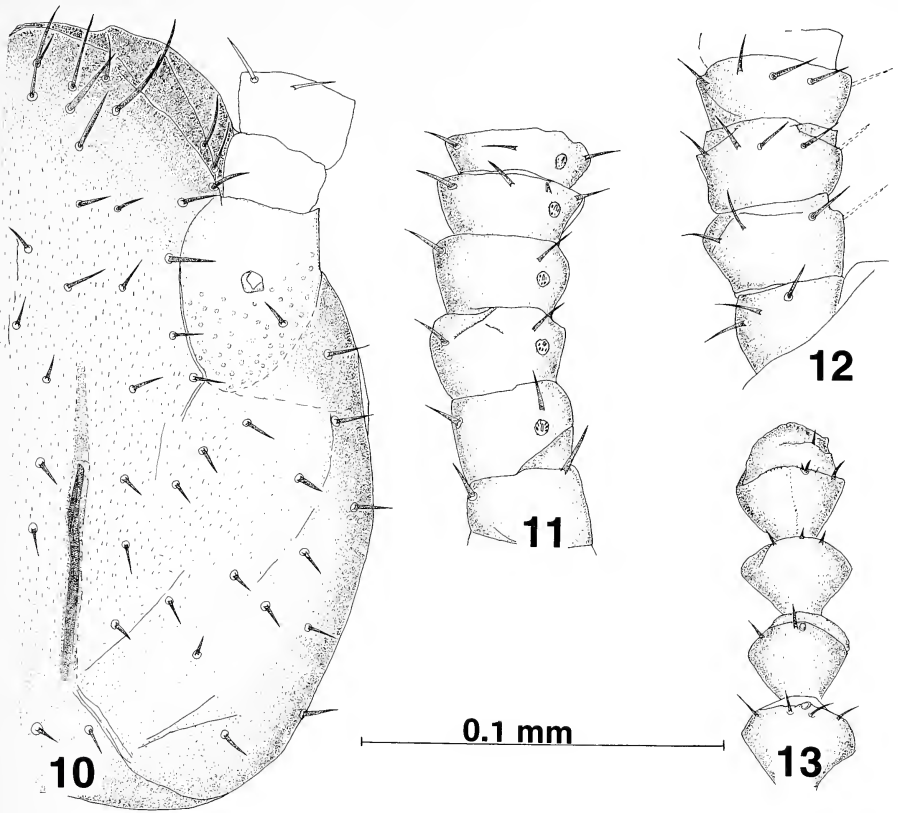
***Ribautiella tuxeni*, new species**

(Figs. 10–35)

Diagnosis. This species closely resembles *R. schoutedeni* but can be readily distinguished by the absence of the anterior part of the central rod of the head and absence of sensory organs along the anterior margins of the antennal segments. The absence of a seta towards the apex on the triangle portion of scuta 2 and 3 separates *R. tuxeni* from other species in the genus.

Description. Length, 2.636 mm. *Head* (Fig. 10). About as long as wide (0.207 long, 0.191 wide), widest at the spiracle openings; central rod distinct posteriorly, reaching almost to $\frac{1}{2}$ length of head, anteriorly weak, usually not evident; anterior-lateral arms absent; dorsal surface sparsely setose, covered with a vestiture of short hairs (visible only at $1000 \times$ +). Ventral surface sparsely setose, more numerous anteriorly, some areas with a vestiture of short hairs. Mouth parts obscure, not readily visible in the holotype specimen. Postantennal organ small (0.0057×0.0059), round with a distinct opening. *Antennae* (Figs. 11, 12, 13). Holotype with 19 (left) or 20 (right) segments. Width of segments 1, 2, 3 respectively 0.042, 0.040, 0.0393; length of inside seta on segments 1, 2, 3 respectively 0.009, 0.008, 0.009. Each segment with a ring of setae along the anterior margin, number increasing towards apex; a second whorl of setae absent; antennal setae of two types, one with a distinct basal pore and the other without; a distinct, small circular organ, medially on each segment, set towards the inside margin; secondary “sense” organs (normally present in many Symphyla species) at the apex of the segments reduced to 1–2, or absent. *Scuta* (Figs. 14–30). There appear to be 24, sometimes poorly defined, setal bearing sclerites; scuta 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, are triangle-shaped posteriorly, scuta 1, 14, 16, 17 are rounded “plates,” scuta 2, 3, 6, 9, 12, 15 may be considered divided into a basal rounded area and the posteriorly directed, double triangle-shaped areas; all scuta with a vestiture of short hair visible at magnifications of $1000 \times$ or more; sparsely setose. *Cerci* (Figs. 32, 33). A little longer than wide (0.090 length, 0.041 width); sparsely setose, setae long (0.017); apical seta short, about one-half as long as width of cerci at base (0.022); apex without striations; surface covered with a distinct vestiture of short hairs. *Genital opening* (Fig. 35). One longitudinal row of small, short setae along each side of the opening. *Legs* (Figs. 31, 34), sternal plate, coxal sac and styli (Fig. 35). Leg pair 1 (Fig. 34) vestigial with 1 distinct apical spine. Leg pair 12 (Fig. 31) sparsely setose, claws equal. Sternal plate with 3 small setae. Coxal sacs with 2 setae on the anterior and posterior areas. Stylets small, densely setose.



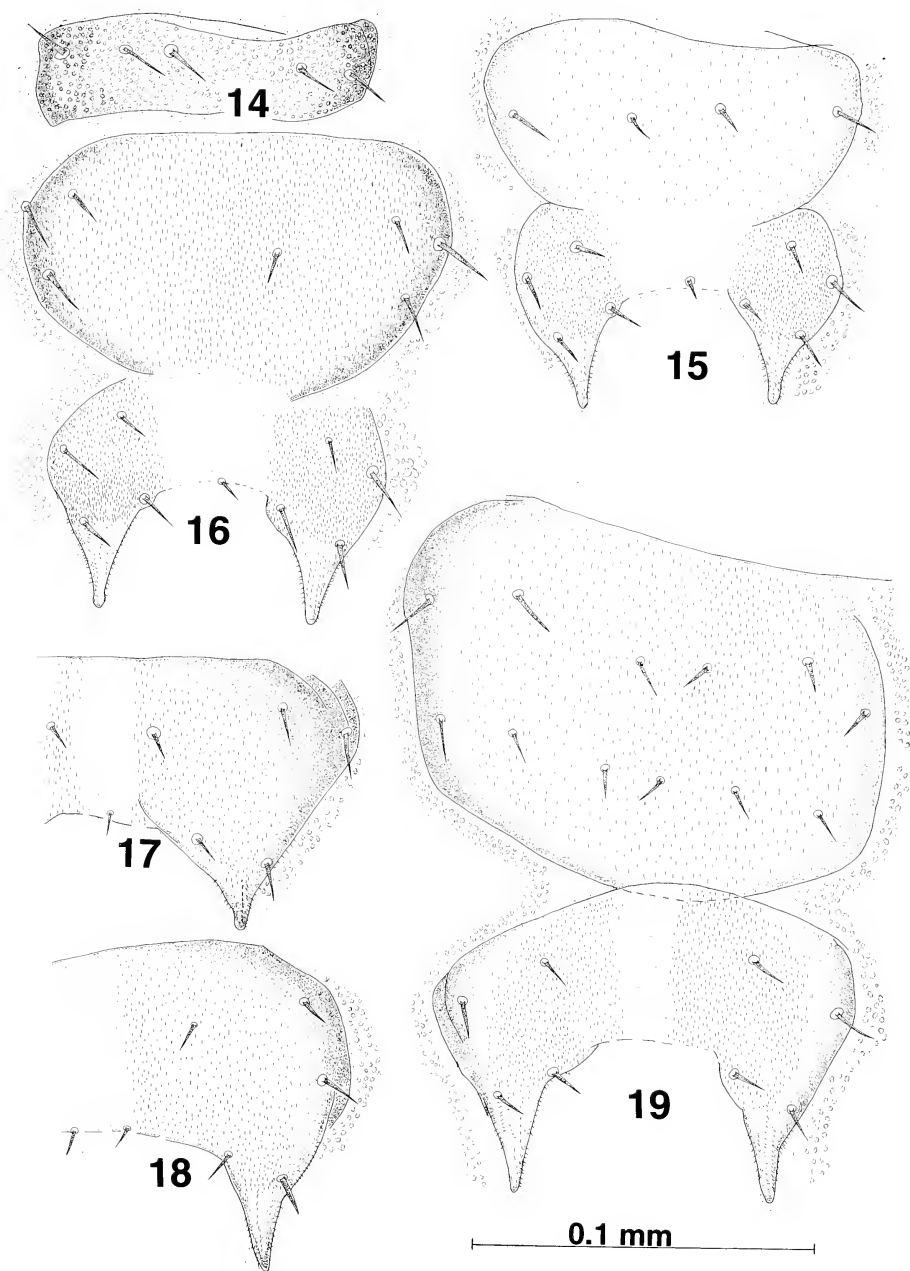


Figs. 10–13. *Ribautiella tuxeni*. 10. Head, dorsal. 11. Antennal segments 2–6, dorsal. 12. Antennal segments 1–4, ventral. 13. Antennal segments, apical 4 segments, dorsal.

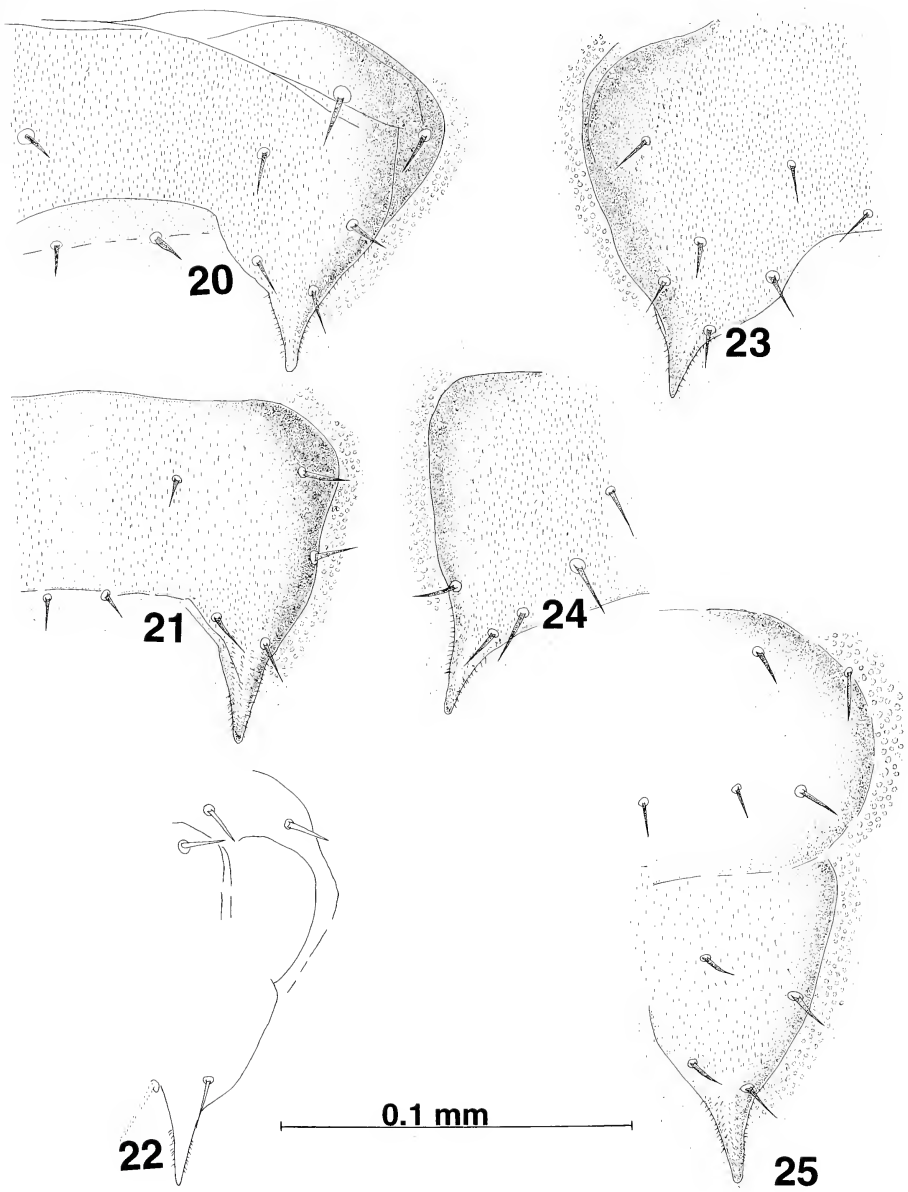
Types. Holotype, Adult, 12 leg pairs, BRAZIL, Taperinha, Santarem, 18.xi.1970, S. L. Tuxen & (?) Jensen. Copenhagen Museum of Zoology, Denmark. Paratype: Immatures, 4 specimens with 11 leg pairs, collecting data same as the Holotype. 3 paratypes Copenhagen Museum of Zoology, 1 paratype American Museum of Natural History, New York, NY, USA.

Etymology. This species is named in honor of S. L. Tuxen who made many valuable contributions to the study of apterygote insects and the Symphyla, and who was one of the collectors of the five specimens described here.

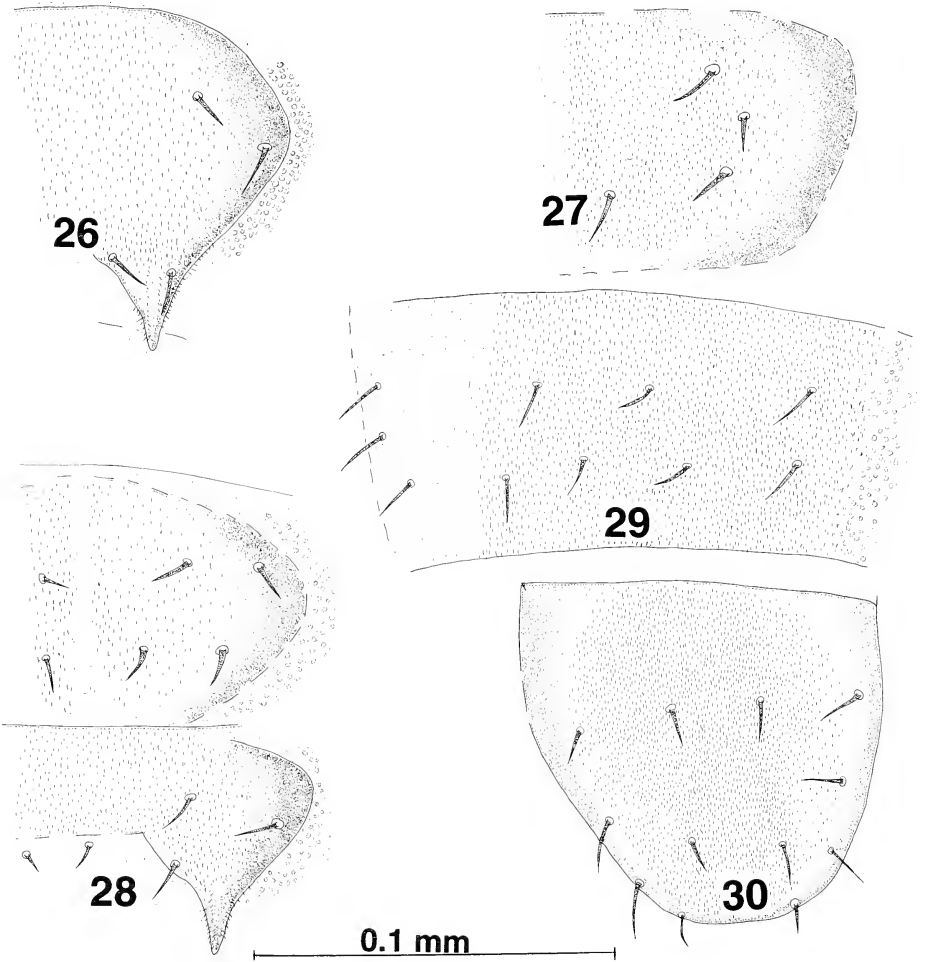
Figs. 5–9. *Ribautiella schoutedeni* Hinschberger. 5. Head, dorsal. 6. Scuta 1, 2, 3. 7. Antennal segments, apical. 8. Antennal segments, basal (Redrawn from Hinschberger, 1954). 9. *R. borbonica*. 9. Scuta 1, 2, 3, 4 (Redrawn from Jupeau 1954).



Figs. 14–19. *Ribautiella tuxeni*. Dorsal scuta. Scuta 1, 2, 3, 4, 5, 6 for figs 14, 15, 16 17, 18, 18 respectively.



Figs. 20–25. *Ribautiella tuxeni*. Dorsal scuta. Scuta 7, 8, 9, 10, 11, 12 for figs. 20, 21, 22, 23, 24, 25 respectively.



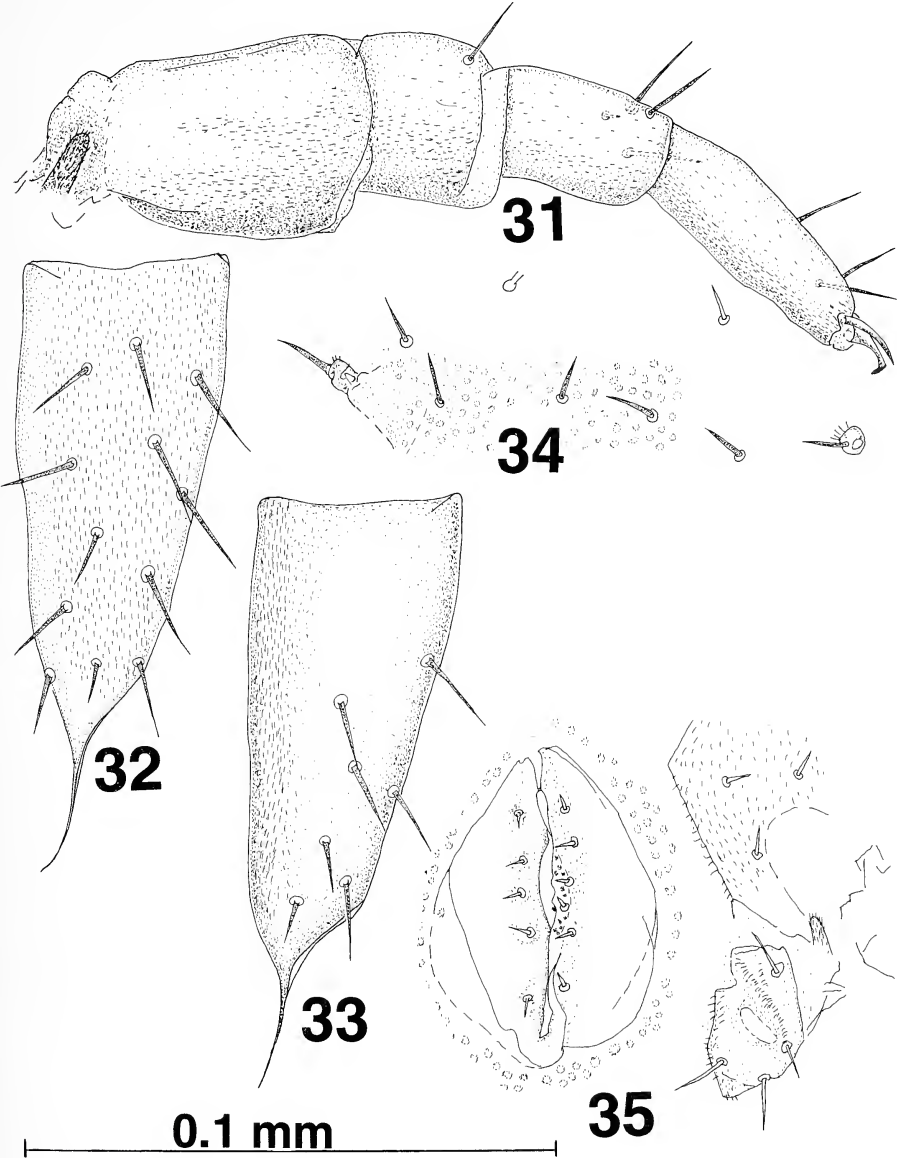
Figs. 26–30. *Ribautiella tuxeni*. Dorsal scuta. Scuta 13, 14, 15, 16, 17 for figs. 26, 27, 28, 29, 30 respectively.

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I wish to thank Dr. H. Enghoff of the Zoological Museum, Copenhagen who has so kindly loaned a large number of specimens for study. Ms. Kim Love, my technical assistant, prepared the specimens and mounted them for study Douglas Tallamy, D. Schwaninger and Zhengliang Tao read the manuscript and offered helpful suggestions.

LITERATURE CITED

Brolemann, H. W. 1926. Myriapodes recueillis en Afrique occidentale francaise ar l'Administrateur en Chef L. Duboscq. Arch. Zool. exp. gen. 65:1–159.



Figs. 31–34. *Ribautiella tuxeni*. 31. Leg 12, anterior face. 32. Cerci, dorsal. 33. Cerci, ventral. 34. Body segment 1, ventral sternal area, vestigial leg pair 1. 35. Body segment 4, ventral sternal area, genital opening, accessory sac, styli, coxal plate area.

- Hinschberger, A. 1954. Symphyles d'Afrique tropicale. Publ. Cult. comp. Dian. Angola 23: 11-36.
- Jupeau, L. 1954. Symphyles de Nosy-Be et la Reunion. Mem. Inst. Scient. Madagascar, Ser. A 9:105-127.
- Rochaix, B. 1956. Contribution a l'etude des Symphyles de Madagascar. Mem. Inst. Scient. Madagascar, Ser. A 10:231-244.

NOTES AND COMMENTS

J. New York Entomol. Soc. 106(4):209–211, 1998

NOTES ON BROODING BEHAVIOR IN THE SAWFLY *NEMATUS TILIAE* (HYMENOPTERA: TENTHREDINIDAE: NEMATINAE)

The term 'subsocial insects' has been used to refer to those which provide parental care for their offspring (Eickwort, 1981; Tallamy and Wood, 1986). Such subsocial behavior has been regarded as one of the prerequisites for the evolution of eusociality in insects (Wilson, 1971). In Hymenoptera with haplo-diploidy which promotes social evolution (Hamilton, 1964), a continuum of social habits, nest construction, guarding offspring, provisioning, communal breeding and reproductive caste differentiation, is found among species of Apocrita (Wilson, 1971). However, despite sharing the same genetic system, basic parental attendance without nesting is the most developed form of sociality in Symphyta and has hitherto been described in relatively few species (Takizawa, 1957; Dias, 1975; 1976; Naumann, 1984; Shinohara, 1986; Kudo et al., 1992; Macdonald and Ohmart, 1993). To analyze comprehensively the evolution of sociality in the Hymenoptera, further information on social behavior in a variety of taxa including primitive ones will be needed. Here we report new observations on apparent brooding behavior in *Nematus tiliae* Zinovjev.

Observations were carried out in Meiji, Akaigawa, Hokkaido, Japan (43°00.82'N, 140°53.89'E). This sawfly was extremely rare; only three clutches with females were found in early September 1996, and none were discovered in 1997 despite intensive investigations at the same site. The clutches were deposited on the underside of leaves in the most apical position of shoots on a Japanese linden, *Tilia maximowicziana* Shirasawa. Two clutches, an egg-mass and an egg-shell mass with first-instar larvae, and the imprint of an egg-mass (without larvae) were found on one leaf. The eggs of one egg-mass hatched soon after discovery. Another clutch, first-instar larvae with an egg-shell mass, was on a different leaf. Accurate clutch size could not be determined, but was estimated at 90–140 by counting hatched larvae and the remaining egg shells.

In subsocial insects, especially in non-nesting species, parent females often show a remarkable posture of attendance and respond against disturbance with specific guarding behavior (Eickwort, 1981; Tallamy and Wood, 1986). All three *Nematus* females discovered straddled the egg-mass (Fig. 1), as in some other subsocial sawflies (e.g., Dias, 1975). When the brooding females were disturbed with visual or tactile stimuli, they showed aggressive responses, opening their mandibles and fanning their wings. Larvae that had hatched from three clutches dispersed on natal leaves and individually fed on them making small holes. Nevertheless, females remained in the same posture on the egg-shell masses, and like the females attending egg-masses, they retained their aggressive responses against disturbance. Even when the brooding females were prodded repeatedly with a pair of forceps, they never



Fig. 1. A *Nematus tiliae* female straddling an egg mass on a *Tilia* leaf.

moved from the egg-mass or the egg-shell mass. This sawfly is most likely to be semelparous.

The function of brooding females seems to be physical defense of their eggs against natural enemies, as was shown in the pamphiliid sawfly *Cephalcia isschikii* Takeuchi (Kudo et al., 1992) and other subsocial insects (Tallamy and Wood, 1986; Trumbo, 1996). Further observations and experiments will clarify the adaptive significance of maternal behavior in this sawfly.—*Shin-ichi Kudo*,¹ *Masahiro Ohara*,² and *Akihiko Shinohara*³, ¹*Department of Biology, Naruto University of Education, Naruto, Tokushima, 772-8502 Japan*; ²*Systematic Entomology, Faculty of Agriculture, Hokkaido University, Sapporo, Hokkaido, 060-8589 Japan*; ³*Department of Zoology, National Science Museum (Natural History), Tokyo, 169-0073 Japan*.

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LITERATURE CITED

- Dias, B. F. de S. 1975. Comportamento pre-social de sinfitas do Brasil Central. I. *Themos olfesi* (Klug) (Hymenoptera: Argidae). Stud. Ent. 18:401–432.
Dias, B. F. de S. 1976. Comportamento pre-social de sinfitas do Brasil Central. II. *Dielocerus diasi* Smith, 1975 (Hymenoptera: Argidae). Stud. Ent. 19:461–501.

- Eickwort, G. C. 1981. Presocial insects. Pages 199–280 in: H. R. Hermann (ed.), *Social Insects*, vol. II. Academic Press, New York, NY.
- Hamilton, D. W. 1964. The genetical theory of social behavior, I. II. *J. Theor. Biol.* 7:1–52.
- Kudo, S., K. Maeto and K. Ozaki. 1992. Maternal care in the red-headed spruce web-spinning sawfly, *Cephalcia isschikii* (Hymenoptera: Pamphiliidae). *J. Insect Behav.* 5:783–795.
- Macdonald, J. and C. P. Ohmart. 1993. Life history strategies of Australian pergid sawflies and their interactions with host plants. Pages 485–502 In: M. R. Wagner and K. F. Raffa (eds.), *Sawfly Life History Adaptations to Woody Plants*. Academic Press, San Diego, Calif.
- Naumann, I. D. 1984. An apterous female sawfly (Hymenoptera: Symphyta) from Papua New Guinea. *Syst. Ent.* 9:339–349.
- Shinohara, A. 1986. A new apterous sawfly from Sulawesi, Indonesia (Hymenoptera: Pergidae: Perreyiinae), and the pleural origin of the ventral region of the sawfly mesothorax. *Syst. Ent.* 11:247–253.
- Takizawa, Y. 1957. Studies on a Japanese-sawfly, *Pachynematus itoi* Okutani (Tenthredinidae, Hymenoptera). II. The ecology and its life history. *New Ent.* 6:17–29. (in Japanese with English summary)
- Tallamy, D. W., and T. K. Wood. 1986. Convergence patterns in subsocial insects. *Annu. Rev. Ent.* 31:369–390.
- Trumbo, S. T. 1996. Parental care in invertebrates. *Adv. Stud. Behav.* 25:3–51.
- Wilson, E. O. 1971. *The Insect Societies*. Harvard University Press, Cambridge, Mass.

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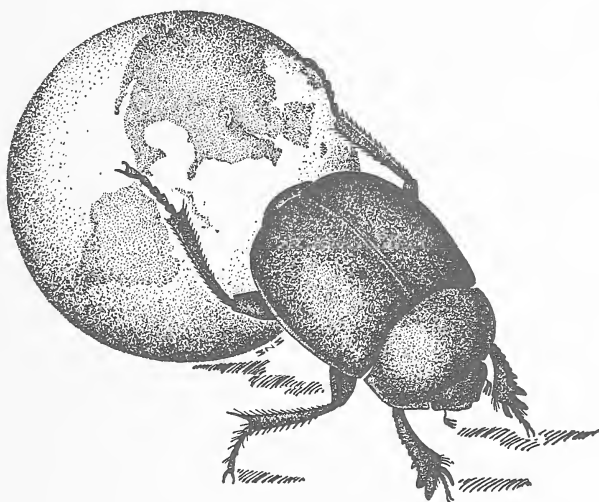
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**NOTES ON THE GENUS *LACCOTREPES* STÅL
(HETEROPTERA: NEPIDAE) IN THE MALAY ARCHIPELAGO,
WITH THE DESCRIPTION OF TWO NEW SPECIES**

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Abstract.—Two new species of *Laccotrepes* are described from Indonesia, *L. celebensis* from Sulawesi, and *L. sondaicus* from Sumbawa and Flores. Nomenclatural and distributional notes are given for *Laccotrepes* species occurring in the Malay Archipelago.

Here we describe two new species of *Laccotrepes* from Indonesia, *L. celebensis* from Sulawesi, and *L. sondaicus* from Sumbawa and Flores. The names are needed for a work on nepid male genitalia in preparation by SLK. The new species are compared to other Australasian species, which comprise an assemblage that is taxonomically separate from the African nepid fauna. Zoogeographically the Australasian and African *Laccotrepes* overlap only in Iran (see Polhemus, 1995a).

The last major revisionary notes on Australasian *Laccotrepes* were offered by Lundblad (1933), but these only treated a few species. The nomenclatural history of this genus has been complicated by a lack of understanding of species-group taxa named from the region by Linnaeus (1758), Fabricius (1775, 1794, 1803) and Ferrari (1888), and by the lack of any comprehensive modern treatment of the genus, especially for the Oriental region. Montandon (1897) gave synonymical notes on some Ferrari species, and Esaki (1926) published a note on the Linnaean species. Ravisankar and Venkatesan (1988) gave a key to the south Indian species and redescribed two species. Polhemus (1995b) showed that *Laccotrepes fuscus* (L.), long thought to be an Asian species (see Lundblad 1933), is actually synonymous with the common African species known until recently as *L. brachialis brachialis* Gerstaecker. Poisson (1965) furnished a catalog of nepid taxa from Africa along with figures of the male parameres of all known African species, but even such a minimal treatment is unavailable for the Orient.

A work is in progress by JTP to analyze the scattered and arcane literature, establish synonymies, furnish an analysis of type specimens, redescribe all Australasian species, and provide a key. This revisionary work has progressed sufficiently to be certain that the new species proposed here have not previously been described. One of us (JTP) has studied the enigmatic Ferrari types held in the Naturhistorisches Museum of Wien in this regard in an effort to preclude further synonymy.

The following notes concern the *Laccotrepes* species of the Malay Archipelago, including the Philippines and the island of New Guinea. The Australian *L. tristis* (Stål) is distinct and closely related to *L. papuus* Montandon of New Guinea, however quite unlike the other species found in the Malay Archipelago, having a tumid mesosternum and lacking a significant basal protuberance on the fore femur.

Below, *L. celebensis* n. sp. is compared with members of the Australasian *Lac-*

cotrephes grossus group. This group is presently comprised of six species: *L. tristis* (Stål), *L. celebensis* n. sp., *L. grossus* (F.), *L. papuus* Montandon, *L. robustus* Stål, and *L. pfeiferiae* (Ferrari); the latter five occur in the Malay Archipelago as broadly defined here, and may be separated by the characters given in Table 1.

Laccotrephes grossus (F.) is the most common and widespread of these species, occurring throughout most of tropical Asia. *Laccotrephes papuus* Montandon is currently known only from the island of New Guinea, where it is uncommon. *Laccotrephes robustus* Stål and *L. pfeiferiae* (Ferrari) have been treated by various authors as synonyms, however here we treat them as distinct species, with *L. robustus* currently restricted to the Philippines, and *L. pfeiferiae* occurring widely throughout the remainder of tropical Asia. Montandon, who extensively studied Asian *Laccotrephes*, vacillated between considering these two species as synonyms or distinct species, but near the end of his studies (Montandon, 1909) he decided that *L. pfeiferiae* was a good species, mainly based on the shape of the prosternal carina when viewed laterally. Here we concur, as several somatic characters seem to consistently separate them (Table 1, and Figs. 6C, 6D).

The somatic characters found to be most useful in species discrimination are the shape and setifiration of the antennae, the shape of the prosternal carina and setifiration along its posterior margin, and to a lesser degree the morphology of the head and eyes (Table 1). The presence or absence of a distinct subdistal tooth in the pfemoral groove of males separates species groups, as does body size.

In this work, the junior author has described and illustrated in detail the male genitalia, including deep structures. This analysis is intended to present the latest interpretation of these structures for the genus *Laccotrephes*, and examine their utility, or lack thereof, in the taxonomy of the genus *Laccotrephes* (see Figs. 4, 5, and discussion below under the species descriptions). Discouragingly, even in the two distantly related species described here, the deep genitalic structures appear to provide only minimal information for species discrimination. The male parameres of *L. sondaicus*, described below, are unique and diagnostic, but in many closely related Australasian species the parameres exhibit only subtle differences.

Materials and methods. The genitalia dissection protocol followed was the one used by Keffer (1996) for the dissection of *Curicta* specimens. Only one modification was made in that protocol. The dried *Laccotrephes* specimens required 20 minutes in hot water for relaxation whereas the more diminutive *Curicta* specimens needed only 10 minutes.

Specimens used for description or comparison were either originally preserved in 75% ethyl alcohol (ETOH), or softened in ETOH if dry mounted, then the debris loosened in an ultrasonic cleaner, sometimes with repeated alternating brushing and ultrasonication to render them clean enough for diagnosis. In some specimens the antennae from one side were removed, cleaned and mounted on a point to properly examine the complement of setae; in a few specimens some of the long setae are broken, leaving only stubs.

All line drawings were prepared with a drawing tube mounted on a Wild stereo microscope, except the sketches of the prosternal carinae in lateral view. The dorsal habitus painting of *L. celebensis* was prepared with an airbrush using a water base acrylic paint, supplemented with charcoal, graphite, and pastels.

The specimens examined in the preparation of this work were mostly collected

Table 1. Comparison of species of the *Laccotrepes grossus* group based on somatic characters.

	Posterior margin prosternal carina	Antennal setation segments 2 & 3	Eye length/ eye width; Eye width/ interocular distance	Cephalic carina in lateral view	Eyes above or below vertex in lateral view
<i>L. celebensis</i>	Setae bordering posterolateral margins only, often sparse	Segments 2 & 3: numerous stiff setae on anterior surface, length = 1/2 width of segment; Segment 3: with ca. 18-24 long, erect setae on ventral surface; bare on basal 1/4	EL/EW = 20/19; EW/IO = 19/26	Transverse depression at level of anterior 1/3 of eye	About even with vertex
<i>L. grossus</i>	Setae completely surrounding posterior margin	Segments 2 & 3: numerous stiff setae on anterior & ventral surfaces, length +/- width of segment; Segment 3: several rows of ca. 100 setae on ventral surface	EL/EW = 22/17; EW/IO = 17/23	Broadly interrupted at level of anterior 1/3 of eye or carina low and barely interrupted	Far above vertex
<i>L. pfeifferae</i>	Setae bordering posterolateral margins only	Segments 2 & 3: numerous stiff setae thickly set on anterior & ventral surfaces, length = width of segment; Segment 3: several rows of ca. 60-80 erect setae on ventral surface	EL/EW = 30/23; EW/IO = 23/32	Not, or scarcely interrupted at level of mid-eye	Barely above vertex
<i>L. robustus</i>	Setae bordering posterolateral margins only	Segments 2 & 3: stiff setae on anterior surface, length = 1/2 to 3/4 width of segment; Segment 3: with ca. 35-40 long, erect setae on ventral surface, including basally, mainly in one row	EL/EW = 20/20; EW/IO = 20/27	Deep transverse depression at level of anterior 1/3 of eye	About even with vertex (without microtrichia)
<i>L. papuus</i>	Setae completely surrounding posterior margin	Segments 2 & 3: numerous, stiff setae on anterior surface, length = width of segment; Segment 3: with ca. 22-34 curved setae on ventral surface, mainly in one row	EL/EW = 14/13; EW/IO = 13/17	Distinctly interrupted at level of mid-eye	Below vertex

by J. T. Polhemus and D. A. Polhemus during several expeditions to the Malay Archipelago, and are in the J. T. Polhemus Collection, Englewood, Colorado. Additional material was borrowed from the following collections: Nico Nieser Collection, Tiel, the Netherlands (NCTN); Naturhistorisches Museum Wien, Vienna, Austria (NHMW). Types are placed in the U. S. National Museum, Washington, D.C. (USNM).

All measurements are given in millimeters. CL numbers following certain localities refer to a coding system used by the authors to cross-reference specimens and collection data.

***Laccotrephes celebensis*, new species**

Figs. 1, 2A, 3A, 4A–D, 6A

Diagnosis. *Laccotrephes celebensis* belongs the Australasian *Laccotrephes grossus* group that is characterized by the presence of a subdistal tooth in the sulcus of the male profemur, and a moderate to large sized body (25–43 mm, without siphon). Differentiating characters are given in Table 1. *Laccotrephes papuus* Montandon and *L. grossus* (F.) may immediately be separated from the other three by the prominent fringe of soft erect setae completely surrounding the posterior margin of the broad longitudinal prosternal carina (in greasy or dirty specimens these soft setae may be matted down); these setae are found only along the posterolateral margins of the prosternal carina in *L. celebensis*, *L. robustus* Stål, and *L. pfeiferiae* (Ferrari). The shape of the prosternal carina is diagnostic (see Figs. 6A–E), and particularly useful in separating *L. celebensis* and *L. robustus*; in addition to a different shape in lateral view, the prosternal carina in *L. celebensis* is slightly expanded laterally just caudad of middle, then very slightly constricted cephalad of posterior margin, whereas in *L. robustus* the lateral margins of the prosternal carina are straight.

Description. *Size.* Macropterous male, length, 29–35 mm.; greatest width across hemelytra, 10 mm; length of respiratory siphon, 23–35 mm.

Color. General appearance blackish brown, rarely brown; eyes brown. Legs blackish brown, femora with ragged greyish transverse stripes or annuli; see Figure 1. Abdominal venter brown, abdominal sternites reddish brown. Head, pronotum, scutellum, base of hemelytra, legs clothed with numerous tufts of microtrichia.

Structural characters (both sexes). Head long, about 1.1 times as wide across eyes as long in middle; median carina lower than upper level of eyes, distinctly interrupted between eyes, anterior part higher; clypeus and lora well differentiated, maxillary plates large, meeting in front of clypeus; length, 3.77; width, 4.00; interocular space, 1.72. Eyes large, strongly exserted, dorsal surface low, flattened, not raised above vertex, width and length about equal, width 1.11 mm., length, 1.17 mm. Antennal segments two and three very long, two slightly shorter, each inferior surface thickly set with short stiff setae with length about $\frac{1}{2}$ of segment diameter; segment three ventrally set with a sparse row of about 20 long setae.

Pronotum long, broad, very slightly narrowed ahead of humeral angles, lateral margins almost straight, heavily sculptured, with a pronounced longitudinal carina on either side of midline (Figs. 1, 2A); anterior protuberances very high; length, 5.94; posterior width, 10.65; anterior width, 8.71; anterior lobe long, length, 4.00;



Fig. 1. *L. celebensis* n. sp., dorsal habitus.

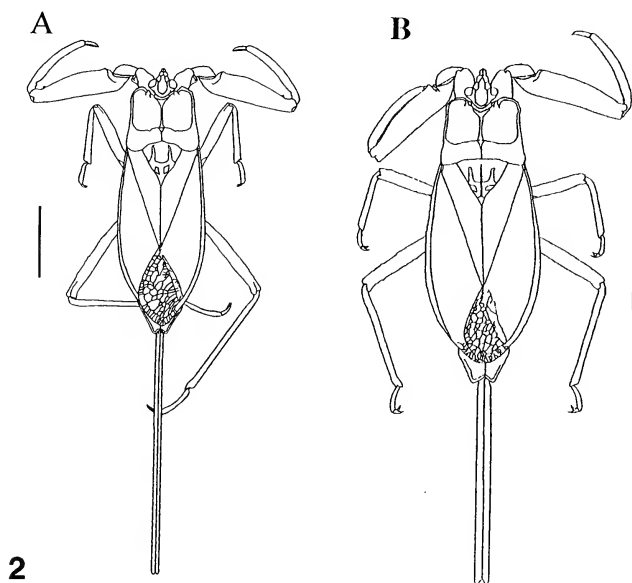


Fig. 2. A. *L. celebensis* n. sp., dorsal habitus. Scale bar = 10 mm. B. *L. sondaicus* n. sp. Dorsal habitus. Scale bar = 10 mm.

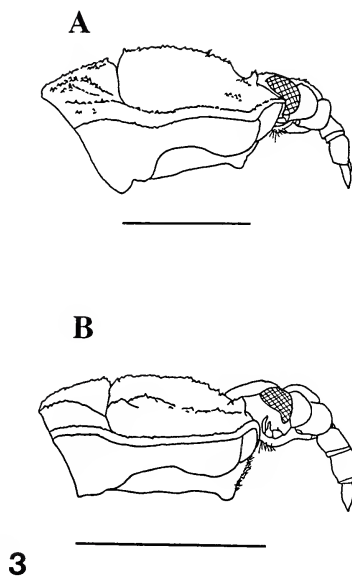


Fig. 3. A. *L. celebensis* n. sp., head and prothorax, right lateral view. Scale bar = 5 mm. B. *L. sondaicus* n. sp. Head and prothorax, right lateral view. Scale bar = 5 mm.

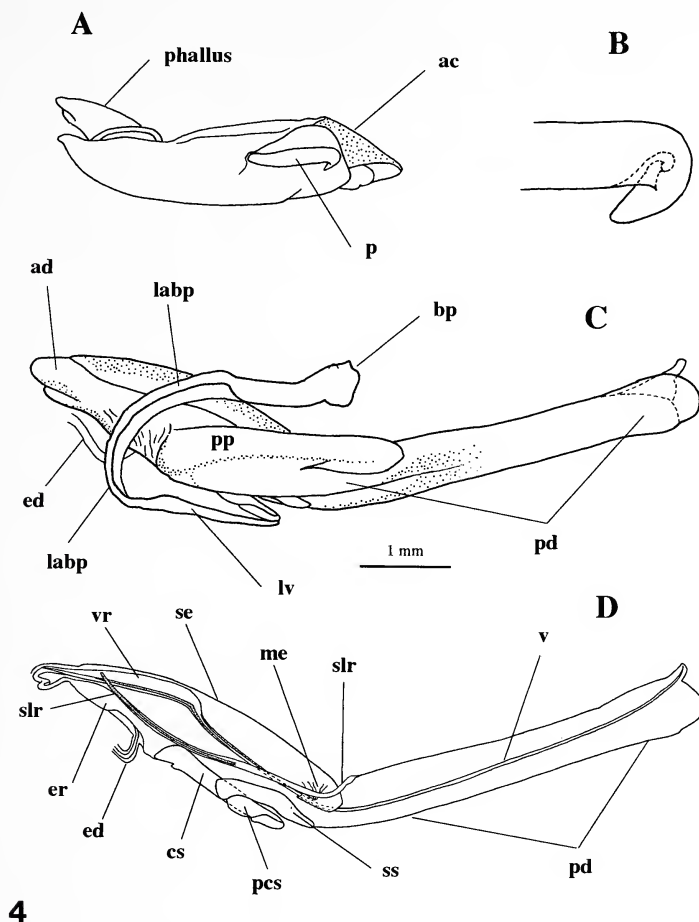


Fig. 4. *L. celebensis*. n. sp. A. Genital capsule, right lateral view (not to scale). B. Paramere, right laterodistal view (not to scale). C. Phallus, right lateral view. D. Deep phallic structures, right parasagittal view (scale same as 4C).

Symbols: ad, anterior diverticulum; bp, basal plate; cs, central strut; ed, ejaculatory duct; er, ejaculatory reservoir; labp, lateral arm of the basal plate; lv, lamina ventralis; me, membranous endosoma; pcs, process of central strut; pp, phallothecal plate; pd, posterior diverticulum; se, sclerotized endosoma; slr, sclerotized lever rod of vesica; ss secondary strut; v, vesica.

posterior lobe short, length 1.94. Scutellum sculptured, length, 6.22; width, 5.66. Prosternal carina almost straight, with anterior knob moderately raised (Fig. 3A), medially slightly tumid, rarely transversely broadly depressed, posteriorly abruptly truncate; posterolateral angles with a distinct fringe of soft erect setae, absent along posterior margin medially. Legs clothed with usual spines and setae; protibia curved, other tibiae straight. Profemur with basal tooth, and a distinct subdistal tooth set in inner furrow, with corresponding notch in fore tibia (Figs. 1, 2A). Mesofemur stout,

slightly flattened; mesotibia slender, flattened, distally with comb of stout brownish spines. Metafemur long; metatibia long, slender.

Male genitalia. Capsule (Fig. 4A). Elongate, width subequal to height. Heavily sclerotized laterally and darkly pigmented; membranous midventrally, broadly so more posteriorly. Anal cone (ac) well sclerotized and darkly pigmented. Parameres (p) distally with simple, blunt hook forming ca. 45° with paramere body (Fig. 4B); distal margin smoothly rounded. In lateral view anterior diverticulum (ad) and lateral arms of the basal plate (labp) of phallus visible projecting anterosuperiorly through anterodorsal capsule opening; distal posterior diverticulum (pd) visible inferior to anal cone and distal to posteroventral margin of capsule.

Phallus (Fig. 4C). Bridge (b) and basal plates (bp) heavily sclerotized, darkly pigmented. Bridge composed of two symmetrical sclerites attached in midline. Lateral arms of basal plates (labp) arch posteriorly then ventrally; entire (not bipartite as in *Nepa* (Keffer, et al., 1990) and *Curicta* (Keffer, 1996)). Labp unite ventrally to form midventral lamina ventralis (lv) which projects posteriorly to articulate with ventroposterior end of central strut (cs). Anterior diverticulum (ad) elongate, sclerotized and darkly pigmented; in lateral view lying at ca. 45° angle to posterior diverticulum (pd); clearly delimited from phallothecal plates (pp) by vertical and horizontal sutures; ventrally open except proximal tip; dorsally connected to medial sclerotized endsoma (se), and to phallothecal plates (pp) posterolaterally. Phallothecal plates heavily sclerotized, darkly pigmented; proximal inner walls of pd continuous medially with membranous endsoma (me) and laterally to medial surface of distal phallothecal plates.

Deep phallic structures (Fig. 4D). Single, median central strut (cs) sclerotized, darkly pigmented; articulating posteriorly with distal end of lamina ventralis (lv). Just dorsal to this articulation, central strut produced laterally into symmetrical, processess of the central strut (pcs) which, in lateral view, begin narrowly and then expand inferiorly as they course anterosuperiorly. Anteriorly central strut weakly bifurcate, partially hollowed out, and attached to posterior end of the ejaculatory reservoir (er). Paired, symmetrical secondary struts (ss) flanking central strut sclerotized and darkly pigmented; articulates anteriorly with apodemes of proximoventral inner phallothecal plate. Posteriorly secondary struts lie in shallow depressions in ventrolateral walls of posterior diverticulum such that only their distal tips visible in lateral view. Ejaculatory duct (ed) passes between lateral arms of the basal plates (labp) to empty into elongate ejaculatory reservoir (er) which tapers anteriorly to a slender duct which runs short distance anteriorly before entering under ventral surface of vesical rod (vr). Vesical rod travels the length of phallus from proximal anterior diverticulum (ad) to tip of spout-like structure at end of posterior diverticulum (pd). It can be divided into three parts based on cross-sectional morphology. For ca. proximal one-fourth of its length, vr is an inverted, broad, and shallow U-shape, with a prominent median, hyaline dorsal keel. As vr descends into phallotheca, the dorsal fin of vr recedes abruptly and short, symmetrical, dorsolateral processes appear. Simultaneously, vr ventrally draws up into an oval shape that is nearly closed midventrally. As vr continues its descent into the phallotheca and then passes into the posterior diverticulum (pd), first the dorsal keel and then the dorsolateral processes are lost and the ventral surface opens into a broad, square, inverted-U framed dorsally by a thin, sclerotized roof and laterally by thicker, sclerotized walls. A pair

of symmetrical sclerotized lever rods (slr) attached laterally to vesical rod just posterior to posterodorsal margin of anterior diverticulum and from there descend into phallosheca forming shallow concavity before ascending to, and terminating in, proximal part of dorsolateral margin of posterior diverticulum (pd). Proximal one-half of each slr has darkly pigmented core, distally slr's are hyaline. Sclerotized endosoma (se) arches over vr/v from posterodorsal margin of anterior diverticulum (ad) to floor of proximal posterior diverticulum (pd) where becomes membranous (me) and is inverted around vesical rod (vr).

Macropterous female. *Size:* Length, 32–33 mm.; greatest width across hemelytra, 11 mm; length, respiratory siphon, 27–30 mm.

Similar to male except usually slightly larger, profemur without subdistal tooth, abdomen slightly more expanded. Subgenital plate long, slightly exceeding tip of abdomen, with a pair of lateral lobes distally.

Etymology. The species name *celebensis* derives from the island of origin, the Celebes, also known as Sulawesi.

Distribution. Indonesia; Sulawesi, central and northern.

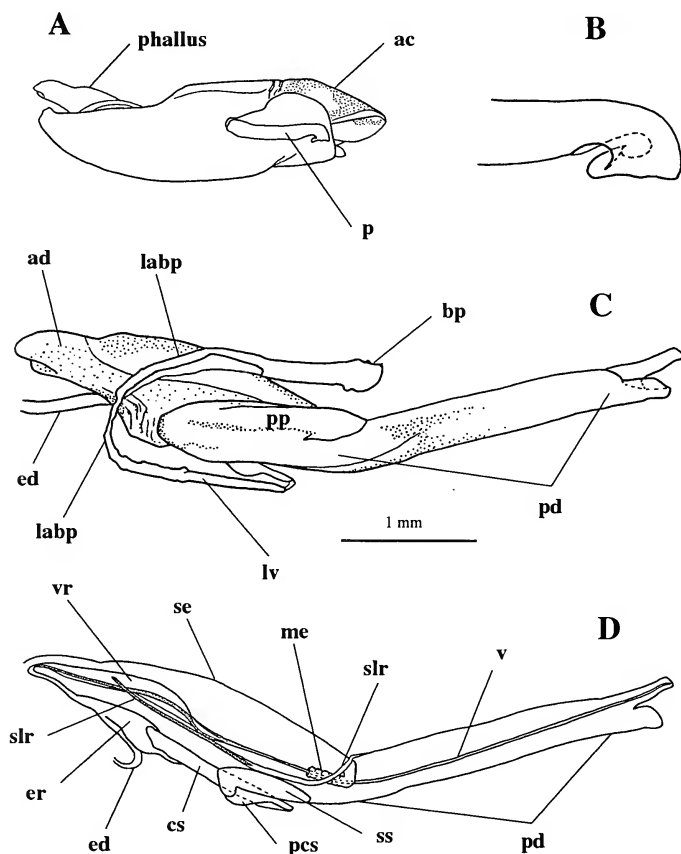
Material examined. Holotype, ♂, INDONESIA, Celebes, **Sulawesi Tengah Prov.**, pond, ca. 1 km. S of Kamarora, el. 660 m, CL 2158, 8.x.1985, J. T. & D. A. Polhemus (USNM). Paratypes: Indonesia, **Sulawesi Tengah Prov.:** 12 ♂, 11 ♀, same data as holotype (JTPC, USNM, NCTN, NHMW); 1 ♀, 10 km. S of Kamarora, el. 950 m, CL 2156, 8.x.1985, J. T. & D. A. Polhemus (JTPC); 1 ♂, 16 km. SE of Palu, el. 200 m, CL 2162, 10.x.1985, J. T. & D. A. Polhemus (JTPC). **Sulawesi Utara Prov.:** 1 ♂ forest streamlet above Lake Mala, el. 1100 m, CL 2114, 9.ix.1985, J. T. & D. A. Polhemus (JTPC); 1 ♀, forest stream S. of Lake Mala, el. 1200 m, CL 2118, 11.ix.1985, D. A. Polhemus (JTPC); 1 ♂, stream 8 km S. of Doloduo in thermal area, CL 2110, 7.ix.1985, J. T. & D. A. Polhemus (JTPC); 2 ♂, small stream in coconut grove, near Desa Kelabat, 23.vii.1994, N 9453A, N. Nieser (NCTN, JTPC).

Laccotrephes sondaicus, new species

Figs. 2B, 3B, 5A–D

Diagnosis. *Laccotrephes sondaicus* may be easily separated from other Australasian *Laccotrephes* species by the moderately large size, laterally dilated abdomen, lack of long setae on antennal segment three, and unique male parameres (all others with distal blade rounded ventrally, rather than truncate ventrally as in *sondaicus*; see Fig. 5B). *Laccotrephes papuus* is approximately the same size, but it is a narrower species, the abdomen is less dilated, and the interocular space is 1.5 times eye width (vs. 2 times eye width in *L. sondaicus*). *Laccotrephes sondaicus* is also unique in having the posterior margin of the metasternum curved (vs. straight or almost so in other species), posterolaterally with two (1 + 1) finger-like projections along the hind coxae.

Only one of the noted differences in genitalia between these two new species can be considered diagnostic (see below). The paramere hook of *L. sondaicus* (Fig. 5B) is unique in the genus (personal observation, SLK) whereas the paramere hook of *L. celebensis* is not uncommon. None of the other genitalic differences noted for these two species can be considered diagnostic because the character variation seen



5

Fig. 5. *L. sondaicus*, n. sp. A. Genital capsule, right lateral view (not to scale). B. Paramere, right laterodistal view (not to scale). C. Phallus, right lateral view. D. Deep phallic structures, right parasagittal view (scale same as 5C).

Symbols: ad, anterior diverticulum; bp, basal plate; cs, central strut; ed, ejaculatory duct; er, ejaculatory reservoir; labp, lateral arm of the basal plate; lv, lamina ventralis; me, membranous endosoma; pcs, process of central strut; pp, phallothecal plate; pd, posterior diverticulum; se, sclerotized endosoma; slr, sclerotized lever rod of vesica; ss secondary strut; v, vesica.

in these species is also found in other *Laccotrephes* species (personal observation, SLK).

Description. *Size.* Macropterous male, length, 26–27 mm.; greatest width across hemelytra, 9–10 mm; length, respiratory siphon, 15–19 mm.

Color. General appearance blackish brown; eyes brown. Legs blackish brown, femora with ragged greyish transverse stripes or annuli. Abdominal venter dark brown. Head, pronotum, scutellum, base of hemelytra, legs sparsely clothed with tufts of microtrichia.

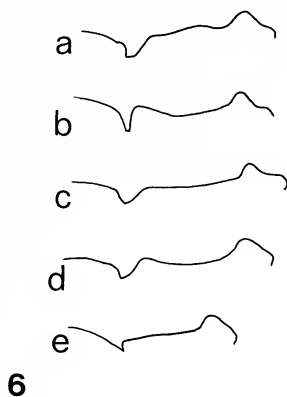


Fig. 6. *Laccotrephes* spp., prosternal carina and anterior part of mesosternum, sagittal section (lateral view, anterior to right). A. *L. celebensis* n. sp. B. *L. grossus* (F). C. *L. pfeifferiae* (Ferrari). D. *L. robustus* Stål E. *L. papuus* Montandon.

Structural characters (both sexes). Head long, very slightly wider across eyes than long in middle; median carina much higher than upper level of eyes, weakly transversely depressed between eyes, anterior and parts of about equal height; clypeus and lora well differentiated, lora large; maxillary plates very large, not quite meeting in front of clypeus (Fig. 3B); length, 2.94; width, 3.05; interocular space, 1.50. Eyes small, exserted, dorsal surface low, flattened, well below vertex, width and length about equal, width 0.72 mm., length, 0.72 mm. Antennal segment two short, about half the length of three, three of moderate length; segment two constricted distally, set with short stiff setae; segment three with short stiff setae only distally, without long setae. Pronotum long, broad, slightly narrowed ahead of humeral angles, slightly widened anteriorly, lateral margins straight medially, moderately sculptured, with a low longitudinal carina on either side of midline (Fig. 2B); anterior protuberances pronounced; length, 3.77; posterior width, 7.33; anterior width, 6.05; anterior lobe long, length, 2.50; posterior lobe short, length 1.39. Scutellum sculptured, length, 4.16; width, 4.03. Prosternal carina broad, slightly convex, sloping posteriorly, evenly curved to posterior margin, with anteriorly knob only slightly raised (Fig. 3B), not posteriorly truncate; not bordered by soft erect setae. Metasternum with posterior margin curved, posterolaterally with two (1 + 1) finger-like projections along the hind coxae. Mid tibia clothed with usual spines; mid and hind tibia and tarsi with long swimming hairs; protibia curved, other tibia straight. Profemur with a low basal protuberance, without a distinct subdistal tooth in inner furrow (Fig. 2B). Mesofemur stout, very slightly flattened; mesotibia slender, flattened, distally with comb of stout brownish spines. Metafemur long, flattened; metatibia long, slender, flattened.

Male genitalia. (Only those features that differ from the description of *L. celebensis* n. sp. are described.)

Capsule (Fig. 5A). Paramere hook (Fig. 5B) approximately parallel to plane of paramere body; distal margin not smoothly rounded, forms ventroposterior angle.

Phallus (Fig. 5C). Outer wall of posterior diverticulum (pd) distally produced into

a bilobed, posteriorly directed process. Inner posterior diverticulum wall produced distally into elongate spout that is not broader proximally. Secondary struts (ss) not visible in lateral view.

Deep phallic structures (Fig. 5D). *Laccotrephes sondaicus* differs slightly from *L. celebensis* in the shape of the secondary struts (ss), the central strut (cs) anteriorly, and the courses followed by the vesical rod (vr) and sclerotized lever rods (slr) through the phallosome.

Macropterous female. Length, 27 mm; greatest width across hemelytra, 10 mm; length, respiratory siphon, 19–20 mm.

Similar to male except larger, profemur without subdistal tooth, abdomen slightly more expanded. Subgenital plate long, narrowly quadrate distally, not exceeding tip of abdomen, with a small pair of lateral angles distally.

Etymology. The species name *sondaicus* is derived from the lesser Sunda Islands, where this species is apparently endemic on the islands of Flores and Sumbawa.

Distribution. Indonesia; Flores, Sumbawa.

Material examined. Holotype. ♂, INDONESIA, **Nusa Tenggara Timur Prov.**, Flores, clear stream, 19 km. SE of Ruteng, el. ~1500 m, CL 2182, 25.x.1985, J. T. & D. A. Polhemus (USNM). Paratypes: Indonesia, **Nusa Tenggara Timur Prov.**, Flores: 1 ♂, 2 ♀, same data as holotype (JTPC). **Nusa Tenggara Barat Prov.**, Sumbawa: 1 ♂, 1 ♀, Madsewu river, 2 km above Badindi, 61 km NW of Bima, 750 m, CL 2174, 20.x.1985, J. T. & D. A. Polhemus (JTPC).

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LITERATURE CITED

- Esaki, T. 1926. Remarks on the Linnéan species of *Nepa* and *Laccotrephes* (Heteroptera: Nepidae). Bull. Brooklyn Entomol. Soc., N. S. 21:177–181.
- Fabricius, J. C. 1775. Systema entomologiae, sistens insectorum classes, ordines, genera, species adiectis synonymis, locis, descriptionibus, observationibus. Libraria Kortii, Flensbergi et Lipsiae, xxx + 832 pp.
- Fabricius, J. C. 1794. Entomologia systematica emendata et aucta, secundum classes, ordines, genera, species adiectis synonymis, locis, observationibus, descriptionibus. Christ. Gottl. Proft, Hafniae, Vol. 4, vi + 434 pp. + Appendix pp. 435–462 + Expolitiones specierum pp. 463–472 + Index, 5 pp. (unn.).
- Fabricius, J. C. 1803. Systema Rhingotorum secundum ordines, genera, species adiectis synonymis, locis, observationibus, descriptionibus. C. Reichard, Brunsvigae, x + 314 pp.
- Ferrari, E. 1888. Die Hemipteren-Gattung *Nepa* Latr. (sens. natur.). Annln. Naturh. Mus. Wien 3:161–194, 2 pls.
- Keffer, S. L., J. T. Polhemus and J. E. McPherson. 1990. What is *Nepa hoffmani* (Heteroptera:

- Nepidae)? Male genitalia hold the answer, and delimit species groups. J. New York Entomol. Soc. 89:154–162.
- Keffer, S. L. 1996. Systematics of the New World waterscorpion genus *Curicta* Stål (Heteroptera: Nepidae). J. New York Entomol. Soc. 104:117–215.
- Lundblad O. 1933. Zur Kenntnis der aquatilen und semi aquatilen Hemipteren von Sumatra, Java und Bali. Archiv für Hydrobiologie, 1933, Suppl. Bd. 12, Tropische Binnengewasser 4:1–195, 263–498.
- Montandon, A. L. 1897. Viaggio di Leonardo Fea in Birminia e regione vicine. LXXV. Hemiptera Cryptocerata. Ann. Mus. Civico Storia Nat. Genova 17:365–377.
- Montandon, A. L. 1909. Nepidae et Belostomatidae. Notes diverses et descriptions d'epèces nouvelles. Ann. Mus. Nat. Hungarici 7:59–70.
- Poisson, R. A. 1965. Catalogue des Héteroptyères Hydrocorises Africano-Malgaches de la famille Nepidae (Latreille) 1802. Bull. I. F. A. N. 27 (Ser A, 1):229–269.
- Polhemus, J. T. 1995a. Family Nepidae Latreille, 1802 - water scorpions, water stick insects, pp. 14–18. In Aukema, B. and C. Rieger, Eds., Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
- Polhemus, J. T. 1995b. The identity and synonymy of *Nepa fusca* Linnaeus 1758 (Heteroptera: Nepidae). Proc. Entomol. Soc. Wash. 97:123–127.
- Ravisankar, S. and P. Venkatesan 1988. Redescription of two Oriental species of genus *Laccotrephes* Stål (Heteroptera: Nepidae) with a key to south Indian species. Entomon. 13: 227–234.

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THREE NEW GENERA OF DERAEOCORINI (HETEROPTERA: MIRIDAE: DERAEOCORINAE) FROM SOUTH AMERICA

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Abstract.—The new genera *Acutifromiris*, *Cephalomiroides*, and *Scutellograndis* are described to accommodate four new species of Miridae from South America and the incertae sedis species, *Eurychilopterella acutifrons* Carvalho. The structures of the male genitalia are illustrated for all species and dorsal habitus views are given for selected species. Scanning electron micrographs of the head and pronotum, metathoracic scent efferent system, and the pretarsus are also provided. The relationships of *Acutifromiris*, *Cephalomiroides*, and *Scutellograndis* to other New World Deraeocorini genera are discussed.

Keywords. Heteroptera, Miridae, Deraeocorinae, Taxonomy, Chile.

During a study of the “*Eurychilopterella* complex” of genera (Stonedahl et al., 1997), three undescribed species of the tribe Deraeocorini were discovered in a collection of Chilean material borrowed from the Canadian National Collection. *Cephalomiroides* and *Scutellograndis* are here described to accommodate these species. *Acutifromiris* is described to include the new species *A. chilensis* and *Eurychilopterella acutifrons* Carvalho, a species placed as incertae sedis by Stonedahl et al. (1997). Terminology for structures of male genitalia follow Kelton (1959) and Stonedahl et al. (1997). All measurements are given in millimetres. Body length is measured from the tip of the tylus to the apex of the hemelytral membrane.

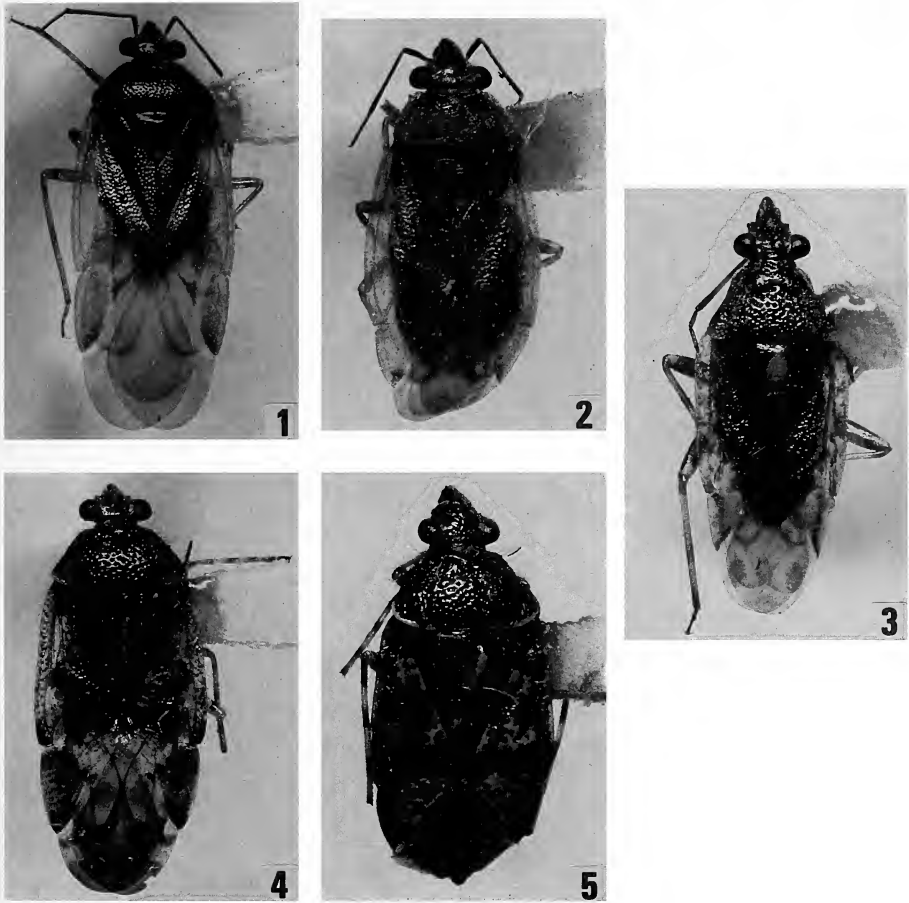
***Acutifromiris*, new genus**

Figs. 1–2, 6–8, 15–20

Type species. *Eurychilopterella acutifrons* Carvalho, here designated.

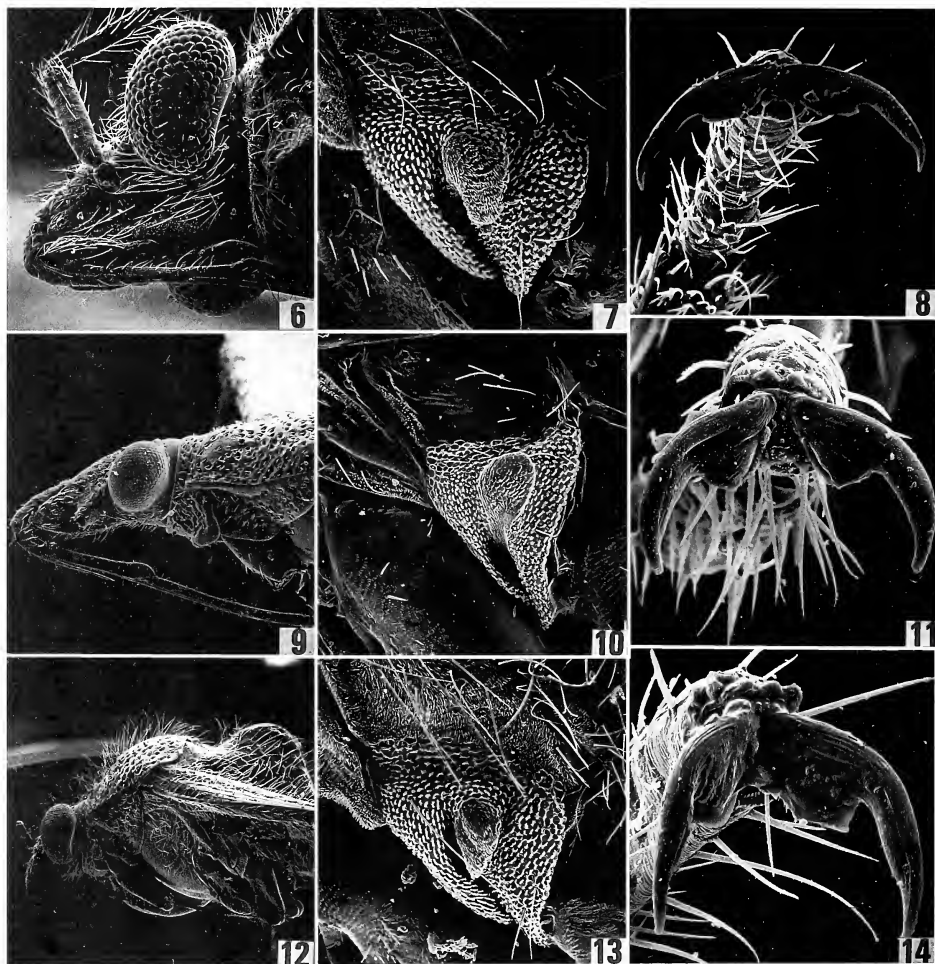
Diagnosis. *Acutifromiris* is distinguished from other New World genera of Deraeocorini by the following combination of characters: head strongly produced anterior to antennal fossae, cone-shaped; gular region flattened, with several weak transverse striations basally, lacking distinct carinae; peritreme of metathoracic scent efferent system strongly elevated, bulbous, coarsely sculptured (Fig. 7); shaft of male left paramere not noticeably expanded distally (Figs. 15–17); and vesica of male genitalia with weakly developed apical lobes and narrow sclerotized process attached to vesica base by fine membrane (Fig. 19). The species of this genus bear a strong superficial resemblance to *Eurychilopterella* species, but the two genera are readily distinguished by the characters given in the following discussion.

Description. Male. Macropterous, length 5.10–5.85; yellow brown with dark brown or black areas on pronotum, calli, and hemelytra; dorsum covered with short, semi-



Figs. 1–5. Dorsal habitus illustrations of Deræocorinae species. 1–2. *Acutifromiris chilensis*, male and female, respectively. 3. *Cephalomiroides nigrifrons*, male. 4–5. *Scutellograndis nahuelbuta*, male and female, respectively.

erect, white setae. *Head* (Figs 1–2, 6): Broader than long in dorsal view; postero-dorsal margin straight; vertex flat, twice as broad as width of eye; frons produced anteriorly beyond antennal fossae; junction with tylus depressed; mandibular and maxillar plates weakly swollen; bucculae short, expanded; gula broad, concave, with small ridges basally and toward margin at base of antennal fossae, set with long erect white setae; eyes prominent, rounded, occupying entire height of head in lateral view, projected laterally to anterior margin of pronotum; buccal cavity subspherical. *Labium*: Extending to the second abdominal segment. *Antennae*: Cylindrical, linear, situated near ventral margin of eyes; fossae nearly touching margin of eye; segment I thicker than remaining segments; segment II longer than remaining segments; segment III and IV thin; all segments set with erect brown setae. *Thorax*: Pronotum.



Figs. 6–14. Scanning electron micrographs of Deraeocorinae species. 6–8. *Acutifromiris chilensis*. 6. Head, ventral view. 7. Metathoracic efferent system. 8. Pretarsus. 9–11. *Cephalomiroides nigrifrons*. 9. Head, lateral view. 10. Metathoracic efferent system. 11. Pretarsus. 12–14. *Scutellograndis nahuelbuta*. 12. Head, pronotum and scutellum, lateral view. 13. Metathoracic efferent system. 14. Pretarsus.

Trapeziform, punctate; posterior angle rounded; anterior margin with distinct collar; posterior margin straight; anterolateral margin weakly concave; calli flat, depressed mesally; posterior lobe of disk moderately elevated. Scutellum. Flat, smooth. Metathoracic scent efferent system as in Fig. 7. Evaporative area well developed; peritreme textured, rounded distally. *Hemelytra*: Punctate; nearly parallel-sided; emboliar margin slightly concave apically; embolium developed, wider than diameter of antennal segment I; cuneus longer than wide; cuneal incisure distinct; membrane with

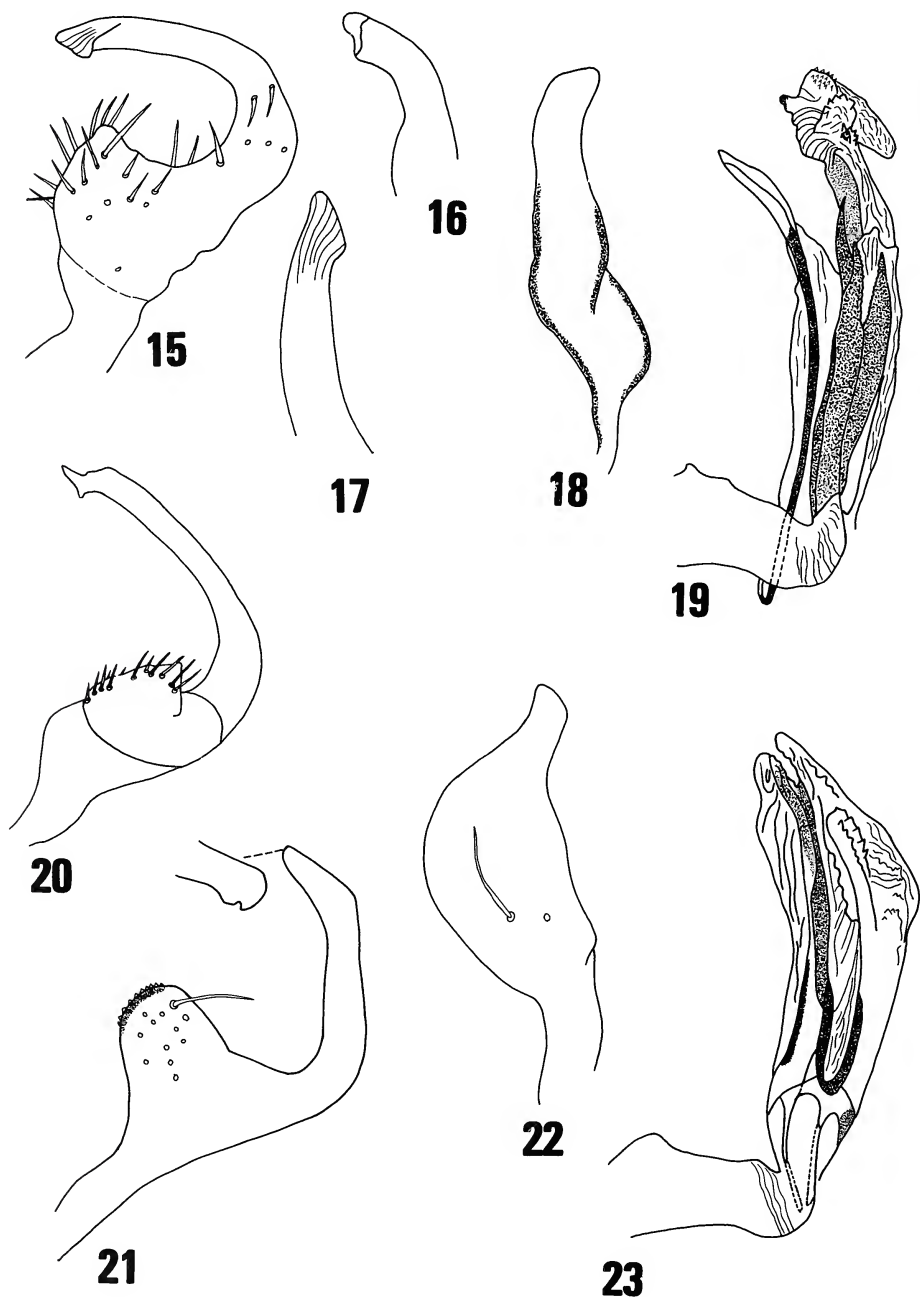
two cells, primary cell longer and rounded apically. *Legs*: Linear, cylindrical; pro- and mesotibia enlarged apically; tarsi linear, segment I longer than remaining segments; segment II short, rounded; segment III three times longer than II; protibiae covered with bristle like setae intermixed with spinules; claws (Fig. 8). *Genitalia*: *Genital capsule*. As broad as long; aperture broad, suboval; paramere sockets set relatively close together and elongate in form. *Left paramere* (Figs. 15–17, 20). Sensory lobe broad, expanded distally; angle strongly curved; shaft long, slightly expanded apically, with inner margin concave subapically; arm bearing long setae dorsally. *Right paramere* (Fig. 18, *A. chilensis* n. sp., only). Relatively small, elongate; apex acute. *Phallosome*. Moderately sclerotized. *Vesica* (Fig. 19, *A. chilensis* n. sp., only). Sclerotized basally, finely toothed near gonopore; membranous sac with teeth apically; angle of posterior ductus seminis giving rise to an elongate sclerotized spicule, slightly expanded apically.

Female. Macropterous, length 4.05–4.50; similar to male in structure, color and vestiture except as noted in species description.

Etymology. Named for the cone-shaped and strongly produced head anterior to the antennal fossae.

Discussion. In a review of the “*Eurychiloptera* complex” of genera, Stonedahl et al. (1997) established that the nominal species *E. acutifrons* Carvalho was not congeneric with the type of the genus, *E. lurida* Reuter, because it lacked the major defining characters of the group: gular region of head broadly concave with transverse striations and prominent lateral carinae; hemelytra with rows of punctures along the anal vein, claval suture and R+M vein; metathoracic scent efferent system with strongly elevated smooth peritreme; and vesica with two or three elongate membranous lobes apically. Stonedahl et al. (1997) assigned *E. acutifrons* the status of incertae sedis pending a more detailed review of Central and South American Deraeocorini. Our further investigations of the tribe, while not exhaustive, have failed to reveal a described genus to accommodate this species, so we are describing the new genus *Acutifromiris* to receive *E. acutifrons* and the new species *A. chilensis*. *Acutifromiris* is distinguished from other genera of Deraeocorini by the characters given in the preceding generic diagnosis.

The relationship of *Acutifromiris* to other genera of Deraeocorini is uncertain. It possesses the elongate head, long labium, and bulbous, textured peritreme that typifies certain members of the *Eurychiloptera* complex, but lacks the broadly concave, striated gular region, rows of punctures on the hemelytral veins, and large distal lobes of the male vesica that are diagnostic of the genera placed in this group by Stonedahl et al. (1997). It is similar in general appearance to *Iridiomiris* China, but it is distinguished by the following combination of characters: thinner antennal segments I and II; eyes not strongly pedunculate; punctuations of pronotum more deeper and scattered; broader anterior margin of pronotum; shaft of left paramere with inner margin concave subapically; and vesica with angle of posterior ductus seminis with an elongate sclerotized spicule, slightly expanded apically. A detailed phylogenetic study of at least the Western Hemisphere genera of Deraeocorini is needed to further address the topic of generic relationships of this and other South American genera.



Figs. 15-23. Male genitalia of Deraeocorinae species. 15-19. *Acutifromiris chilensis*. 15. Left paramere, dorsal view. 16. Apex of the left paramere, dorsal view. 17. Apex of the shaft, ventral view. 18. Right paramere, dorsal view. 19. Vesica. 20. *A. acutifrons* (Carvalho), left

Acutifromiris acutifrons (Carvalho)

Fig. 20

Eurychilopterella acutifrons Carvalho, 1948:57. NEW COMBINATION.

Diagnosis. Similar to *A. chilensis* n. sp., but distinguished by the relatively smaller size; brown general coloration; and the structure of the male genitalia, especially the longer arm of the left paramere with the shaft distinctly produced apically (Fig. 20).

Redescription. Macropterous male; total length 4.65–5.10; yellowish brown general coloration; dorsal vestiture and punctation as in generic description. *Head:* Length 0.60; width across eyes 0.75–0.90; width of vertex 0.45; smooth, brown, two times wider than long; mandibular and maxillar plates dark brown, almost black; eyes black. *Labium:* Length 2.10–2.25, brown. *Antennae:* I, length 0.30, yellow; II (N = 1), 1.05, yellow, dark brown apically; III and IV missing. *Thorax:* Pronotum. Mesal length 0.75–0.90; posterior width 1.55–1.67; brown, punctate. Scutellum. Brown, creamy white apically. *Hemelytra:* Emboliar margins weakly parallel-sided, punctate, uniformly brown; clavus and cuneus sometimes darker; length of the cuneus 0.75–0.78. *Venter:* Brown, dark brown on mesepisternum and metapleura. *Legs:* Linear, evenly yellow. *Genitalia* (Fig. 20).

Female. Unknown.

Types. *Eurychilopterella acutifrons* Carvalho: CHILE, Valparaiso, 1 ♂ (Holotype, without right antenna and abdomen; left antenna with segments III and IV missing), 1945, Guszman (USNM). Paratypes: 1 ♂ (without antennae and abdomen), same data as for holotype, Carvalho (MNRJ).

Discussion. *Acutifromiris acutifrons* is only known from two males collected in Chile. The original description gave “Carvalho” as collector of the holotype, but the affixed label gives Guszman as the collector. Both specimens lack an abdomen, making it impossible to examine and compare the genitalic structures of this species with those of *A. chilensis*. Carvalho’s (1948) drawing of the vesica of *A. acutifrons* is not sufficiently detailed to allow for direct comparison with *A. chilensis*.

Acutifromiris chilensis, new species

Figs. 1–2, 6–8, 15–19

Diagnosis. Similar to *A. acutifrons* Carvalho and *Idiomiris magellanesensis* China in general appearance, but distinguished by head with distinct black stripes basally; calli, scutellum, and two spots on the clavus dark brown to black; and the structure of the male genitalia (Figs. 15–19).

Description. Male (N = 5). Length 5.10–5.55; general color and vestiture as in generic description. *Head:* Length 0.45–0.60; width across eyes 0.88–0.90; width of vertex 0.45; brown; tylus sometimes yellow, darker at junction with bucculae; maxillary plate and bucculae dark brown; mandibular plate and gula yellowish brown. *Labium:* Length 1.80–2.10, brown, last segment dark brown. *Antennae:* I, length

←

paramere, dorsal view (after Carvalho, 1948). 21–23. *Cephalomiroides elongatus*. 21. Left paramere, dorsal view. 22. Right paramere, dorsal view. 23. Vesica.

0.30, dark brown; II, length 0.90–1.20, brown, darker and slightly enlarged apically; III and IV, dark brown, length 0.45–0.49 and 0.30–0.37, respectively. *Thorax*: Pronotum. Median length 0.75–0.84; posterior width 1.50–1.65, yellow, light brown between calli; calli black. Scutellum. Dark brown, marked with yellow at anterior angles and apex. Metathoracic efferent system as in Fig. 7. *Hemelytra*: Clavus, mesally and apically, and corium mesally, dark brown, remaining areas yellowish brown; cuneus usually marked with red; membrane opaque, veins brown. *Venter*: Dark brown. *Legs*: Yellow with dark brown annuli. *Genitalia* (Figs. 15–19).

Female (N = 5) (Fig. 2). Similar to male in general appearance, except slightly smaller with dark brown frons and scutellum, paler cuneus, and mesepisternum sometimes nearly black. Total length 4.05–4.35. *Head*: Length 0.60; width across eyes 0.90; width of vertex 0.52. *Labium*: Length 1.80–2.10. *Antennae*: I, length 0.30; II, 0.75; III, 0.45; IV, 0.30–0.36. *Thorax*: Pronotum. Mesal length 0.75; posterior width 1.50–1.65.

Etymology. Named after the country in which it was collected.

Types. Holotype, ♂, CHILE, Las Cabras, Cord. Chillian, 6/3.iii.1959, L. E. Peña (CNC). Paratypes: CHILE, **Lautin**: 6 ♂♂ and 3 ♀♀, 30 Km NE Villarrico, 1/30.i.1965, L. E. Peña (USNM); 1 ♀, Pemehue, 11.i.1986, Gutierrez (USNM). **Mallica**: 1 ♀, Termas Rio Grande, Valdivian Rain Forest, 23.xi.1979, A. C. Asmolth & J. W. Haganson, on *Chusquea* sp. (CNC). **Nuble**: 6 ♂♂ and 13 ♀♀, Las Cabras, Chilean Vulcain, 7/15.xi.1959, L. E. Peña (CNC; BMNH); 7 ♂♂ and 5 ♀♀, Las Cabras, Cord. Chillian, 6/31.i.1959, L. Peña (CNC; BMNH); 9 ♂♂, Las Cabras, 24.ii.1956, L. Peña, 1460 m (CNC; BMNH); 4 ♀♀, Las Trancas, 15.ii.1959, L. E. Peña (CNC); 1 ♂, Las Cabras, 1460 m, 24.ii.1956 (CNC). **Curico**: 1 ♂, Cubillo, 4.i.1960, L. Peña (CNC).

Material examined. *Iridiomiris magellanesensis* China: CHILE, **Magallanes**, 1 ♂ (holotype), Puerto Williams, 17.i.1959, Roy. Soc. Exped. S. Chile 1958–59, G. Kuschel; 1 ♀ (allotype), same data as holotype; 1 ♀ (paratype), same data as holotype, 18.i.1959 (all BMNH).

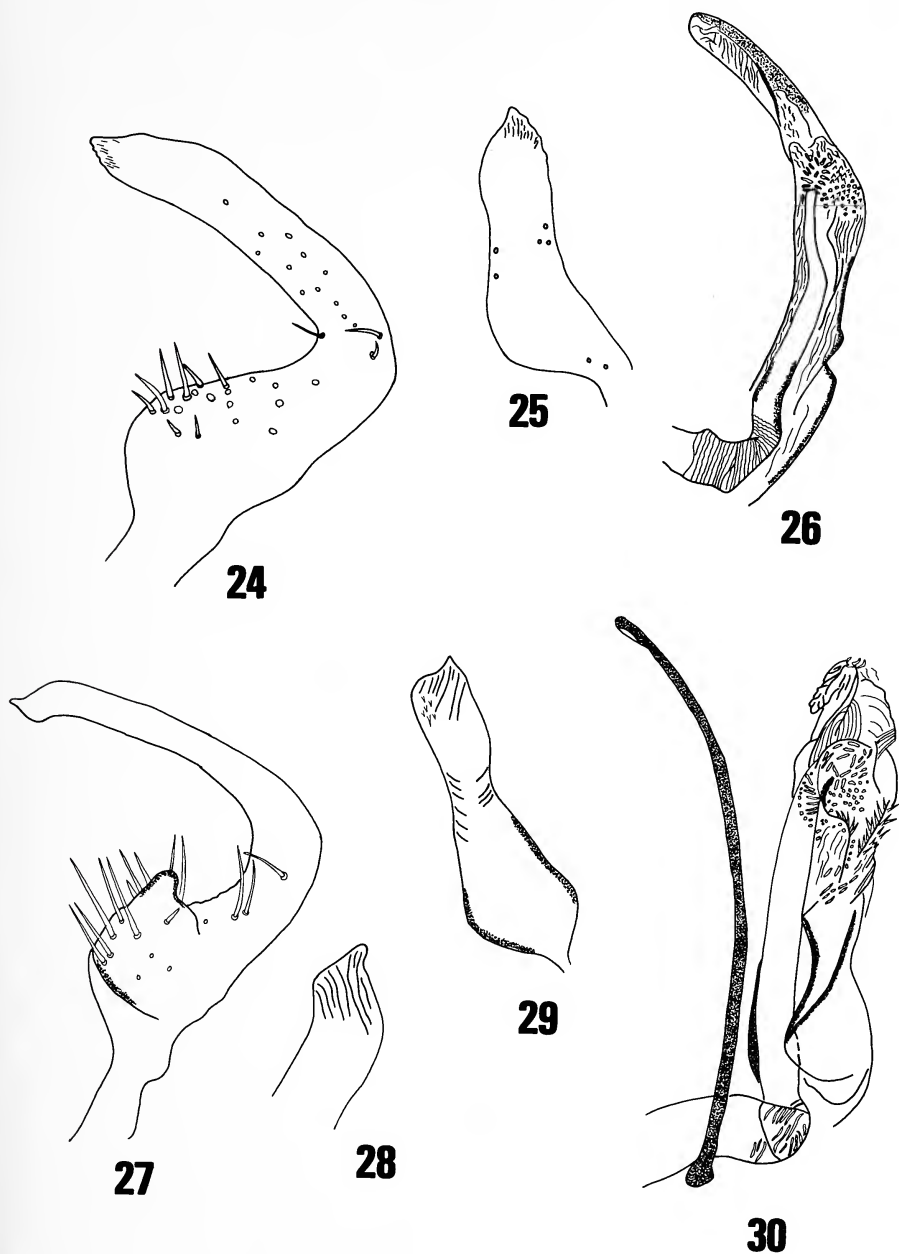
Cephalomiroides, new genus

Figs. 3, 9–11, 21–26

Type species. *Cephalomiroides nigrifrons*, new species, here designated.

Diagnosis. Distinguished from other New World genera of Deraeocorini by the following characters: elongate body; tylus strongly produced, conical; second antennal segment longer than head length; gula weakly concave, bearing distinct ridges mesally, lateral margins carinate, covered with long silvery setae; labium reaching at least to 5th abdominal segment; embolium wide, with row of fine punctures on basal half of R+M vein; peritreme of metathoracic scent efferent system strongly produced, bulbous, coarsely sculptured (Fig. 10); left paramere with strongly produced sensory lobe and shaft not noticeably expanded distally (Figs. 21, 24); and vesica without sclerotized process and recurved apical lobes, sometimes with teeth or spines near gonopore and sclerotized areas basally (Figs. 23, 26).

Description. Male. Macropterous; length 4.20–4.80; brownish yellow general coloration, sometimes with dark brown or black areas on head, pronotum, scutellum and base of clavus; cuneus with dark red tinge; pronotum, head and embolium punc-



Figs. 24–30. Male genitalia of Deraeocorinae species. 24–26. *Cephalomiroides nigrifrons*. 24. Left paramere, dorsal view. 25. Right paramere, dorsal view. 26. Vesica. 27–30. *Scutello-grandis nahuelbuta*. 27. Left paramere, dorsal view. 28. Apex of the left paramere, dorsal view. 29. Right paramere, dorsal view. 30. Vesica.

tate; dorsum with long erect setae mixed with short, suberect, yellow setae. *Head* (Figs. 3, 9): Elongate, nearly as long as width across eyes in dorsal view; vertex smooth or finely punctate, depressed basally, two times broader than eye width in dorsal view; frons declivous; tylus strongly produced, junction with frons depressed; maxillary and mandibular plates weakly swollen; bucculae swollen; gula concave, with distinct ridges mesally and long setae at lateral margins; eyes rounded, occupying entire height of head in lateral view. *Labium*: Reaching 5th abdominal segment, first segment much thicker than remaining segments, segment II and III longer than I and IV, segment III two times longer than IV. *Antennae*: Cylindrical, linear; fossae nearly touching anterior margin of eye; segment II four times longer than segment III, swollen, covered with long, erect setae apically; segment IV slightly longer than III. *Thorax*: Pronotum. Trapeziform, punctate, posterior width about 1.5 times anterior width; anterior margin with distinct collar, sometimes incised mesally, width of collar slightly less than diameter of antennal segment I; posterior margin nearly straight; posterior angles rounded, calli weakly swollen, area between calli depressed; lateral margins carinate; anterior angle rounded; posterior lobe of disk slightly elevated. Mesoscutum. Narrowly exposed. Scutellum. Weakly concave. Metathoracic scent efferent system as in Fig. 10. Evaporative area well developed, peritreme textured. *Hemelytra*: Parallel-sided; embolium wide, two times diameter of antennal segment II; cuneus about 1.6 times longer than wide; cuneal incisure distinct. *Legs*: Pro- and mesofemora nearly cylindrical, metafemora enlarged apically; pro- and mesotibiae enlarged apically; tarsi linear, elongate; segment III longer than I and II, slightly thicker apically; claws broad basally (Fig. 11). *Genitalia*: *Genital capsule*. Asymmetrical, rounded apically; paramere sockets broadly separated; left margin with process at base of paramere insertion. *Right paramere* (Figs. 22, 25). Short, broad, external margin curved. *Left paramere* (Figs. 21, 24). Sensory lobe strongly produced, rounded, set with long setae dorsally; shaft long, acute or rounded apically, sometimes incised on the inner margin. *Phallosheca*. Well sclerotized. *Vesica* (Figs. 23, 26). Sclerotized, comprising several membranous lobes distally, sometimes bearing small teeth; ductus seminis elongated.

Female. Macropterous, length 4.80; similar to male in structure, color and vestiture except as noted in species descriptions.

Etymology. Named for the elongate cephalic capsule and strongly produced tylus of this mirid.

Discussion. Although the relationship of *Cephalomiroides* to other genera of Deraeocorini is not entirely clear, this genus does possess a number of characters that are diagnostic of the "*Eurychlopterella* complex" of genera as defined by Stonedahl et al. (1997): elongate, porrect head with broadly concave, striated gular region; elongate labium; and strongly produced, bulbous peritreme of metathoracic scent efferent system. However, both species of *Cephalomiroides* lack the rows of punctures on the anal vein and outer margin of the clavus, which also are diagnostic of the "*Eurychlopterella* complex", as well as the strongly developed, elongate apical lobes of the male vesica. Considering these discrepancies, we prefer for the moment to place *Cephalomiroides* near but not within the "*Eurychlopterella* complex" pending a more thorough investigation of taxa and characters within the Deraeocorini.

Cephalomiroides elongatus, new species

Figs. 21–23

Diagnosis. Distinguished from *C. nigrifrons*, n. sp. by the head pale yellow dorsally; hemelytra pale yellow, without dark markings; cuneus with faint pink tinge basally; apex of second antennal segment yellowish brown; and structure of the male genitalia (Figs. 21–23).

Description. Holotype male. Total length 4.50; yellowish brown with dark brown areas on pronotum, scutellum, head (laterally) and abdomen. *Head:* Length 0.75; width across eyes 0.75; width of vertex 0.30; dark brown ventrally; frons yellow; tylus yellow, brown apically; vertex white pinkish at base and near eyes. *Labium:* Length 2.40, dark brown. *Antennae:* Linear, brown; I, length 0.30; II, 1.05; III, 1.00; IV, missing; all segments covered with long yellow setae. *Thorax:* Pronotum. Mesal length 0.60; posterior width 1.80; calli dark brown, collar creamy white mesally; disk finely punctate; posterior margin weakly concave; propleura dark brown, punctate. Mesoscutum. Brown with small pale spots at lateral margins. Scutellum. Brown, with pale stripe mesally from base to apex, and two pale spots at each anterior angle. Metathoracic efferent system as in generic description. *Hemelytra:* Pale brown, darker brown at base of clavus; embolium wide; cuneus longer than wide, tinged with red near inner margin, brown apically; membrane opaque. *Venter.* Dark brown. *Legs:* Pale brown with creamy white annuli and long pale setae. *Genitalia* (Figs. 21–23).

Female. Unknown.

Etymology. Named for the elongate head.

Types. Holotype, ♂, CHILE, **Arauco**, Pichinahuel, Cord. Nahuelbuta, 1/10.i.1959, L. Peña (CNC).

Discussion. Although this species is described from a single specimen, the characters given in the preceding diagnosis, especially the structure of the male genitalia, easily distinguished it from *C. nigrifrons*.

Cephalomiroides nigrifrons, new species

Figs. 3, 9–11, 24–26

Diagnosis. Distinguished from *C. elongatus* by the dark-brown to black vertex and frons; apex of antennal segment II and antennal segments III and IV dark brown; broader pale stripe on scutellum; hemelytra with brown spots; and structure of the male genitalia (Figs. 24–26).

Description. Male (N = 4) (Fig. 3). Total length 4.20–4.80; general color yellowish brown with black markings; dorsal vestiture as in generic description. *Head* (Fig. 9): Length 0.90; width across eyes 0.81–0.90; width of vertex 0.30–0.45; brownish yellow near eyes, dorsal surface finely punctate; vertex and frons black, lateral margins of frons sometimes yellow with black marks medially; tylus brown or yellowish brown; maxillary and mandibular plates yellowish brown; eyes black. *Labium:* Length 2.40–2.55, brown. *Antennae:* I, length 0.30, twice as thick as pronotal collar; II, 1.20–1.35, four times longer than I, enlarged apically, dark brown subapically, set with short setae; III and IV subequal, 0.15–0.30 and 0.15–0.39, respectively. *Thorax:* Pronotum. Mesal length 0.75–0.90; posterior width 1.48–1.61; punctate, brownish yellow with black areas towards humeral angles and posterior margin; calli black. Scutellum. Anterior angle dark brown with broad, creamy white mesial stripe.

Metathoracic efferent system as in Fig. 10. *Hemelytra*: Emboliar margins nearly parallel-sided; clavus and cuneus with short, silvery, recumbent setae; clavus black basally; corium and cuneus with light brown spots; cuneus yellow, sometimes with pink tinge apically; membrane opaque, with dark brown areas; veins brown. *Venter*: Dark brown; mesepisternum sometimes black. *Legs*: Linear; femora brown with dark brown spots; tibiae yellowish brown with a pale annulus subapically. *Genitalia* (Figs. 24–26).

Female (N = 3). Similar to male in general structure and coloration, except head more yellow dorsally. Total length 4.80. *Head*: Length 0.45–0.60; width across eyes 0.81–0.90; width of vertex 0.45. *Labium*: Length 2.55–2.70. *Antennae*: I, 0.30; II, 1.05–1.20; III, 0.15–0.30; IV, 0.15–0.30. *Thorax*: Mesal length of pronotum 0.90–1.05; posterior width of pronotum 1.50–1.35.

Etymology. Named for the dark-brown to black frons.

Types. Holotype, ♂, CHILE, **Arauco**, Pichinahuel, Cord. Nahuelbuta, 20.i.1951, L. Peña (CNC). Paratypes: CHILE, **Ñuble**: 2 ♂♂ and 1 ♂, Las Cabras, Chillean Vulcain, 7/15.xi.1959, L. E. Peña (CNC; BMNH); 1 ♀, Las Trancas, 23/30.ii.54, 1260 m (CNC); 1 ♀, Las Trancas, 10.ii.1959, L. E. Peña; 1 ♀, Las Cabras, Cord. Chillian, 6/31.i.1959, L. Peña (CNC). **Arauco**: 1 ♀, Pichinahuel, Cord. Nahuelbuta, 23/31.xi.1958, L. Peña (CNC).

Scutellograndis, new genus

Figs. 4–5, 12–14, 27–30

Type species. *Scutellograndis nahuelbuta*, new species, here designated.

Diagnosis. Distinguished from other New World genera of Deraeocorini by the deeply punctate pronotum and cuneus (Figs. 4, 5); strongly swollen, cone-shaped scutellum; head, antennae, dorsal surface of body and legs with long, erect setae; small, bilobed, coarsely sculptured peritreme of metathoracic scent efferent system (Fig. 13); and structure of male genitalia, especially the left paramere with strongly produced sensory lobe and blunt shaft, apically (Figs. 27–28); and vesica strongly sclerotized, surrounding ductus seminis, with elongate sclerotized process arising from posterobasal margin of ductus seminis (Fig. 30).

Description. Male. Macropterous; length 5.40–5.85; dark brown, sometimes faintly tinged with red especially on cuneus; pronotum and cuneus strongly punctate; dorsum with long, simple, erect, brown setae intermixed with short, semidecumbent, white setae. *Head* (Figs. 4, 12): Declivous, two times wider than long; posterodorsal margin straight; junction of tylus and frons indistinct; maxillary and mandibular plates weakly swollen; gula short, clothed with long setae; eyes subovate, occupying entire height of head in lateral view, projecting laterally in dorsal view; bucculae large. *Labium*: Reaching the metacoxae, segment I shorter and thicker than remaining segments. *Antennae*: Linear; fossae inserted near base of eye and nearly contiguous with anterior margin of eye; segment II longer than remaining segments; all segments with long brown setae, intermixed with short white semierect setae; segment III longer than segment IV. *Thorax*: Pronotum. Trapeziform, punctate, moderately declivous; collar, medially, wider than diameter of antennal segment I; median length subequal to length of antennal segment II; calli weakly elevated; posterior and anterior angles rounded; posterior margin moderately concave. Scutellum. Smooth,

strongly swollen, cone-shaped, higher than pronotum in lateral view. Metathoracic scent efferent system as in Fig. 13. Evaporative area well developed; peritreme bilobed, bulbous distally. *Hemelytra*: Emboliar margins parallel-sided; embolium weakly punctate, two times wider than diameter of antennal segment I; cuneal fracture distinct; cuneus two times longer than wide, deeply punctate; membrane with two cells, secondary cell elongate. *Legs*: Linear; metafemora longer than pro- and mesofemora; protibiae swollen apically; metatibiae linear, with dark spinules, and dark, erect setae longer than tibial width; tarsi elongate, linear, segment I enlarged, segment II short, segment III longer than I and II; claws deeply cleft, broad basally (Fig. 14). *Genitalia*: *Genital capsule*. Longer than broad, narrowed apically; paramere sockets widely separated; right margin of capsule between paramere sockets, expanded. *Right paramere* (Fig. 29). Short, arm expanded basally, apex truncate. *Left paramere* (Figs. 27–28). C-shaped with long setae dorsally; sensorial lobe strongly produced, notched apically; shaft long. *Phallosheca*. Fully sclerotized. *Vesica* (Fig. 30). Membranous, with sclerotized areas basally overlaying ductus seminis, spinous near gonopore, with elongate sclerotized process.

Female. Macropterous; length 4.50–5.40; similar to male in color, structure and vestiture, except abdomen sometimes paler ventrally.

Etymology. Named for the distinct strongly swollen, cone-shaped scutellum.

Discussion. The relationships of *Scutellograndis* to other genera of Deraeocorini are uncertain. In general aspect this genus is similar to *Deraeocoris*, but differs by the greatly enlarged scutellum and the long erect setae on head, antennae, dorsal surface of body, and legs. It is also close to *Eurychiloptera* and *Acutifromiris* by having an elongate sclerotized process in the vesica of the male genitalia, but the length and shape of this process and the unique structure of scutellum easily separate *Scutellograndis* from these two genera. Since our preliminary examination of Old and New World Deraeocorini has failed to reveal other genera with close affinities to *Scutellograndis*, we are unable at present to speculate further on the relationships of this genus to other groups of Deraeocorini.

***Scutellograndis nahuelbuta*, new species**

Figs. 4–5, 12–14, 27–30

Diagnosis. Recognized by the characters given in the generic diagnosis.

Description. Male (N = 4) (Fig. 4). Total length 5.40–5.80; general coloration, surface texture and dorsal vestiture as in generic description. *Head*: Length 0.60–0.75; width across eyes 1.05; width of vertex 0.45; dark brown with two yellow spots near inner dorsal margin of eye; tylus brown; maxillary and mandibular plates yellowish brown; bucculae nearly black; gula yellow basally. *Labium*: Length 1.35–1.65, brown. *Antennae*: I, length (N = 2) 0.45, yellow ventrally, dark brown dorsally; II (N = 1), 1.05, brown; III and IV, dark brown, length (N = 1) 0.45 and 0.28, respectively. *Thorax*: Pronotum. Mesal length 0.75–1.03; posterior width 1.50–1.95; brown, with three dark marks along subposterior margin; posterior margin narrowly pale; collar dark brown, yellow mesally. Mesoscutum. Short, brown. Scutellum. Brown with creamy white stripe along posterior margin of elevation (dorsal view); sometimes black basally. Metathoracic scent efferent system as in generic description. *Hemelytra*: Dark brown, with darker areas at apex of embolium and mesally on

clavus and corium; corium brown, marked with white near base and sometimes spotted with brown along inner apical margin; membrane opaque with white marks. *Venter*. Mesosternum black; metathoracic efferent system yellow with black areas bordering peritreme; abdominal segments dark brown. *Legs*: Pro- and mesofemora yellow, dark brown basally, with brown spots on external surface; metafemora with two dark brown annuli apically; tibiae yellow with dark brown annuli; tarsi yellowish brown. *Genitalia* (Figs. 27–30).

Female (N = 7) (Fig. 5). Similar to male except abdominal segments usually yellow; 9th abdominal segment yellow basally, and dark brown apically. Total length 4.50–5.40. *Head*: Length 0.60–0.75; width across eyes 0.90–1.05; width of vertex 0.45–0.55. *Labium*: Length 1.65–1.80. *Antennae*: I, length (N = 5) 0.45; II (N = 5), 0.90–1.05; III (N = 3), 0.30–0.57; IV (N = 2), 0.30–0.36. *Thorax*: Mesal length of pronotum 1.03–1.05; posterior width of pronotum 1.65–1.80.

Etymology. Named for the type locality, Cordillera Nahuelbuta, Chile.

Types. Holotype, ♂, CHILE, **Arauco**, Pichinahuel, Cord. Nahuelbuta, 20/28.i.1959, L. Peña (CNC). Paratypes: CHILE, **Nuble**: 1 ♂, Las Cabras, Chilean Vulcain, 7/15.ii.1959, L. E. Peña (CNC); 1 ♂, Coquecura, 13.xi.1959, L. E. Peña (CNC.); 3 ♀♀, same data as holotype, 1/10.i.1959 (CNC; BMNH); 1 ♀, Las Cabras, Chilean Vulcain, 7/15.xi.1959, L. E. Peña (CNC); **Aconcagua**: 7 ♀♀, Guardia Vieja, 22.xi.1958, L. E. Peña (CNC; BMNH); 1 ♀, Rio Blanco, 29.xi.1958, L. Peña (CNC); **Coquimbo**: 1 ♀, Had Illapel, 21/25.xi.1958 (CNC); **Curico**: 1 ♂, El Coigo, 1/20.x.60, L. Peña (CNC); 5 ♀♀, Las Cabras, Cord. Chilean, 6/31.i.1959, L. Peña (CNC; BMNH).

Additional material examined. CHILE, **Arauco**: 1 ♂ and 1 ♀, Butamal, Cord. Nahuelbuta, 12.i.1959, L. Peña; 3 ♀♀ and 1 ♂, Las Cabras, Cord. Chilean, 6/31.iii.1959, L. Peña; 1 ♂, Pichinahuel, Cord. Nahuelbuta, 28/31.i.1959, L. Peña; **Aconcagua**: 1 ♀, Rio Blanco, 27.xi.1958, L. Peña; 1 specimen without abdomen, Piscicultura, 21/25.xi.1958 (all CNC).

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LITERATURE CITED

- Carvalho, J. C. M. 1948. Mirídeos Neotropicais, XXX: Gêneros *Ellenia* Reuter, *Eurychilopteryella* Reuter, e *Rhinachloa*, com descrições de espécies novas (Hemíptera). Bol. Mus. Nacional Rio Janeiro-Zoologia 85:1–12.

- Kelton, L. A. 1959. Male genitalia as taxonomic characters in the Miridae (Hemiptera). Can. Entomol., Suppl. 11:72 pp.
- Stonedahl, G. M., J. D. Lattin, and V. Razafimahatratra. 1997. Review of the *Eurychlopterella* complex of genera, including the description of a new genus from Mexico (Heteroptera: Miridae: Deraeocorinae). Am. Mus. Nov. 3198, 33 pp.

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A NEW SPECIES OF *CERCOTMETUS* AMYOT & SERVILLE (HETEROPTERA: NEPIDAE) FROM LAOS

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Abstract.—*Cercotmetus minutus* n. sp. is described from Laos. A revised key to the species of *Cercotmetus* is provided.

Here we describe a new species of *Cercotmetus* from Laos. It is compared to other *Cercotmetus* species, and a revised key to the species of *Cercotmetus* is provided.

METHODS AND MATERIALS

The description was prepared from a specimen in alcohol. Illustrations were produced with a camera lucida.

The specimen examined in the preparation of this work was loaned by the B. P. Bishop Museum, Honolulu, Hawaii (BPBM), the holotype repository. Comparative material used to prepare the key is held in the J. T. Polhemus Collection, Englewood, Colorado.

All measurements are given in millimeters.

Cercotmetus minutus, new species

Figs. 1-3

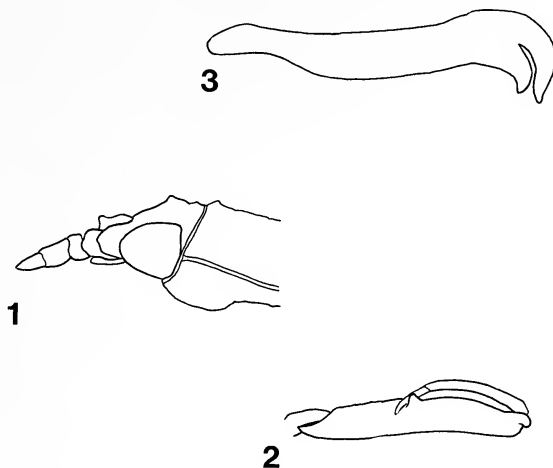
Diagnosis. *Cercotmetus minutus*, with a body length of 28 mm, is by far the smallest *Cercotmetus* species known. The only other known species to approach this length is *C. brevipes* Montandon which has a minimum known length of 32 mm. While *brevipes* and *minutus* both have the mesofemur shorter than the prothorax, *brevipes* lacks the pronounced tubercle on the vertex found in *minutus*, the interocular space of *brevipes* is 1.6 times eye width instead of subequal as in *minutus*, and *brevipes* is a much stouter species.

Description. *Size.* *Macropterous male*, length, 28.0 mm.; greatest width across humeri, 2.3 mm; length, respiratory siphon, 6.0 mm.

Color. Brown.

Structural characters. Interocular space ca. equal to eye width, IO = 1.95 mm, EW = 1.80 mm. Tip of clypeus turned up, appearing in lateral view to possess an anterior tubercle (Fig. 1). Antennae stout, with segment two short, lateral prolongation about ¼ that of segment three, the latter set with stiff setae distally. Anterior collar not prominent, slightly raised, with an inconspicuous blunt projection behind the eyes. Anterior pronotal lobe ca. 2.4 times as long as posterior lobe, humeri scarcely raised.

Prothorax long (8.4 mm), ventrally tricarinate, central keel commencing from between the procoxae, becoming evenly rounded and ending in a depression near pos-



Figs. 1–3. *Cercotmetus minutus*, sp. n. 1. Head, lateral view. 2. Profemur, tibia and tarsus. 3. Paramere.

terior margin, thickly set with microtrichia anteriorly, gradually becoming evanescent posteriorly; lateral keels weakly formed, reaching posterior margin.

Mesososternum evenly rounded between middle coxae, anterolateral margins with two (1 + 1) small dark nodules, barely raised. Metasternum weakly carinate, strongly emarginate posteriorly, median notch V-shaped; metaxyphus narrow, evenly curved posteriorly to an acute apex, mesocoxae twice as far apart as metacoxae.

Procoxae slightly more than $\frac{1}{3}$ as long as prothorax, length 3.0 mm. Profemur short (4.9 mm), median tooth short, located about in middle (Fig. 2). Meso- and metathoracic legs slender, without annuli, tibia set with a row of long swimming hairs. Mesofemur (7.2 mm) shorter than length of prothorax. Metafemur (8.4 mm) extending to ca. $\frac{3}{4}$ of fifth abdominal sternite. Hemelytral membrane large, evenly tapering posteriorly, reaching middle of sixth abdominal tergite.

Male operculum narrow, sharply carinate. Male paramere typical of *Cercotmetus* (Fig. 3). Respiratory siphon (6.5 mm) 1.65 times as long as sixth sternite, 2.64 times as long as operculum.

Female: unknown.

Etymology. The trivial name *minutus* refers to the small size of this species.

Distribution. Laos.

Types Holotype, ♂, LAOS, 10 km NW Vientiane; 10.vi.1972; C. W. Heckman coll. (BPBM)

REVISED KEY TO THE SPECIES OF *CERCOTMETUS*

(After Lansbury, 1973)

1. Vertex raised between the eyes but without a prominent tubercle. 2
 Vertex with a prominent tubercle 4
2. Body length not exceeding 42 mm; mesofemur clearly shorter than prothorax
 *C. brevipes* Montandon

- Body length not exceeding 47 mm; mesofemur longer than prothorax. 3
3. Eyes small, widely separated (interocular space/eye width ~ 2); profemoral tooth small, shorter than the distal width of the protibia *C. robustus* Montandon
Eyes larger (interocular space/eye width ~ 1.3); profemoral tooth larger, longer than the distal width of the protibia *C. dissidens* Montandon
4. Mesofemur shorter than prothorax *C. minutus* Keffer & Polhemus, n. sp.
Mesofemur longer than prothorax 5
5. Mesofemur not more than one fifth longer than prothorax 6
Mesofemur between one-third and one-half longer than the prothorax 7
6. Not more than 40 mm long *C. pilipes* (Dallas)
At least 48 mm long *C. fumosus* Distant
7. Mesosternum with a prominent keel *C. asiaticus* Amyot & Serville
Mesosternum not keeled 8
8. Respiratory siphon about twice as long as the operculum . . . *C. strangulatus* Montandon
Respiratory siphon about three times as long as the operculum 9
9. Distal third of sixth tergite raised and often very hairy; meso- and metafemora with long hairs distad ventrally, with many (80–100) setae forming a thick brush on hind femora. *C. compositus* Montandon
Distal third of sixth tergite not unduly raised and never hairy; meso- and metafemora bare distad ventrally, sometimes with a few slender setae (ca. 25) in two sparsely set rows distally on hind femur only *C. asiaticus* Amyot & Serville

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LITERATURE CITED

- Lansbury, I. 1973. A review of the genus *Cercotmetus* Amyot & Serville, 1843 (Hemiptera-Heteroptera: Nepidae). Tijds. Entomol. 116:83–106.

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TWO NEW SPECIES OF *MICROVELIA* FROM TREEHOLES, WITH NOTES ON OTHER CONTAINER-INHABITING VELIID SPECIES (HETEROPTERA: VELIIDAE)

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Abstract.—*Microvelia cavicola* sp. n. and *Microvelia karunaratnei* sp. n. are described from water-filled treeholes in Panama and Sri Lanka respectively. Distributional and synonymical notes are given for other veliid species inhabiting treeholes.

Key words. Heteroptera; Veliidae; *Microvelia*, taxonomy, new species; tree hole habitat; Panama; Sri Lanka.

Although a number of veliid species are known from container habitats in the New World, and some have been recorded from the Old World, only five of these are known to inhabit tree holes, i.e., *Paravelia myersi* (Hungerford, 1931) from Trinidad and Panama, *Cylicovelia kenyana* Polhemus and Copeland (1996) from Kenya, a *Microvelia* sp. from Guadalcanal (Laird, 1956:166), plus two new species of *Microvelia* described below from Panama and Sri Lanka.

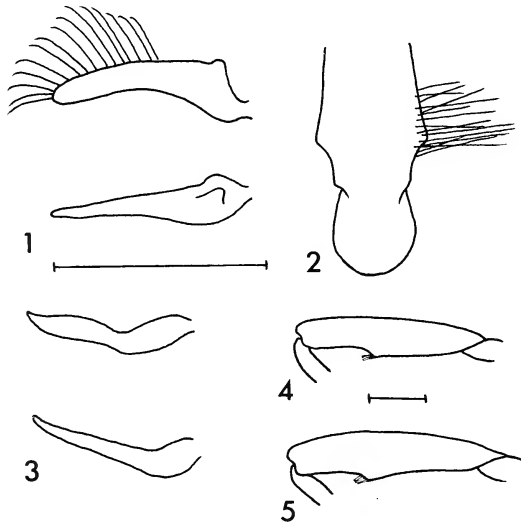
In the American tropics the terrestrial and arboreal bromeliads that have water pockets harbor a guild of eight veliid species endemic to them (reviewed by Polhemus & Polhemus, 1991), belonging to the genera *Paravelia* Breddin and *Microvelia* Westwood. In addition, two *Microvelia* species are known from crabholes on the Pacific coast of Costa Rica (Polhemus & Hogue, 1972), and one *Microvelia* species from a "crab burrow" on the Atlantic coast of Costa Rica (Drake, 1952). Yang and Kovac (1995) recorded species of *Baptista* and *Lathriovelia* (Microvelinae) from water filled bamboo internodes in West Malaysia. All of these taxa are so far known only from their particular container habitats.

MATERIALS AND METHODS

One of the new *Microvelia* species described here was discovered by S. Yanoviak during an extensive study of the tree hole fauna of Panama. The second new species, from Sri Lanka, was found long ago by the late P. B. Karunaratne, living in water filled rot holes four or five feet off the ground.

Genitalia drawings were made with a Wild microscope at 80× from preparations immersed in glycerin. Leg drawings were made with a camera lucida at 40×, then magnified. All measurements were made with a micrometer grid.

The following institutions either lent material, or are repositories; Smithsonian Institution, National Museum of Natural History, Washington (USNM); American Museum of Natural History, New York (AMNH); J. T. Polhemus Collection, Englewood, CO (JTPC); National Museum of Sri Lanka, Colombo (CNMS); Zoological Museum, University of Copenhagen (ZMUC); S. Yanoviak Collection (SYC).



Figs. 1–2. *Microvelia cavicola* n. sp. 1. Male right paramere, two views; 2. Male proctiger, dorsal view, long setae shown on right side only. Scale bar = $\frac{1}{4}$ mm.

Figs. 3–5. *Microvelia karunaratnei* n. sp. 3. Male right paramere, two views; 4–5. Male legs (usual setae not shown), 4. Middle femur, lateral view; 5. Hind femur, lateral view. Scale bar = $\frac{1}{4}$ mm

***Microvelia cavicola*, new species**

Figs. 1–2

Diagnosis. *Microvelia cavicola* belongs to the *Microvelia laesslei* group which also includes the species *M. ancona* Drake & Chapman, *M. distanti* Lundblad, and *M. laesslei* Drake & Hussey. This group is characterized by: brown or blackish ground color; pronotum covering mesonotum and all or most of metanotum; antennal segments III and IV slender, subequal in length, and about 1.5× the length of segment II; micropters with bright white wing pads; apters with bright silvery or white markings on basal abdominal tergites and connexiva; macropters with extensive bright white markings basally on the hemelytra, plus sometimes an apical white spot; male parameres long, symmetrical; obligate inhabitants of tree holes or bromeliad water pockets.

The three described species of the *M. laesslei* group were included in a key to bromeliadiculous veliids furnished by J. and D. Polhemus (1991), where the micropterous morph of *M. cavicola* keys to *M. laesslei* but drops there in the macropterous morph, as it has only broad basal white spots on the hemelytra rather than the entire basal third white as in *M. laesslei*. The micropters differ from *M. laesslei* in the much smaller wing pads (vs. large and covering almost the basal abdominal tergites in *M. laesslei*), and shorter and broader body. The very long, setose parameres and modified proctiger with lateral tufts of long setae separate *M. cavicola* from all other described *Microvelia* species.

Description. *Size.* Micropterous male, length 1.91–2.16 mm (mean = 2.00 mm, N

= 10); width 0.58–0.68 mm (mean = 0.63 mm, N = 10). Micropterous female, length 2.16–2.41 mm (mean = 2.29 mm, N = 10); width 0.68–0.83 mm (mean = 0.76 mm, N = 10). Macropterous male, length 2.16–2.27 mm (mean = 2.22 mm, N = 10); width 0.79–0.83 mm (mean = 0.81 mm, N = 10). Macropterous female, length 2.30–2.45 mm (mean = 2.37 mm, N = 10); width 0.83–0.94 mm (mean = 0.88 mm, N = 10).

Color. Ground color dark brown tinged with rufous; venter brown. Head brown, tinged with rufous, light brown ventrally; rostrum luteous on basal three segments, piceous distally. Pronotum with anterior lobe entirely orange brown, extending onto pleural region; collar brown, disc dark brown, slightly lighter laterally. Abdominal tergites dark brown; tergite VII, connexiva brown. Wing pads bright white, sparsely set with long dark setae. Legs, antennae testaceous to brown; antennal segments III, IV lighter.

Micropterous male with head of moderate length, declivant anteriorly; length 0.43; eyes small, width of eye/interocular space, 0.09/0.47. Pronotum long, extending over base of abdominal tergite II (first visible tergite), humeri not prominent; disc set with numerous foveae; length:width, 0.51: 0.63. Wing pads rounded posteriorly, rarely acuminate, tips surpassing posterior margin of pronotum. Abdominal tergites II–V subequal in length (0.12–0.14), VI slightly longer (0.15), VII longest (0.23); inter-segmental suture between II–III, III–IV narrow, with numerous hair-free pits; tergites V–VII with a median hair-free longitudinal stripe on midline finely rugulose, shining. Entire dorsum set with fine pubescence, appearing golden in certain light angles, longer on tergites II–IV. Connexiva moderately raised, tapering evenly along tergite VII, posterolateral angles of abdomen set with long setae directed caudad. Mesosternum, metasternum tumid, posterior margin of mesosternum with a pair of posteriorly directed tubercles, one on either side of midline, in contact with metasternum. Abdominal venter set with short appressed setae, mixed with longer setae laterally; ventrite VII unmodified, posterior margin slightly concave. Legs clothed with short setae intermixed with sparse longer setae; antennae set with short setae and scattered longer setae. Legs unarmed, unmodified; all femora weakly fusiform; all tibia straight, anterior tibia with short ventral comb, $\frac{1}{5}$ of tibial length. Claws, arolia normal, slender.

Antennal segments I, II stout, III, IV long, slender; formula I:II:III:IV; 0.17: 0.14: 0.26: 0.37.

Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2 of fore leg, 0.47: 0.37: 0.21: 0.0; of middle leg, 0.56: 0.53: 0.12: 0.19; of hind leg, 0.60: 0.64: 0.14: 0.21.

Abdominal terminalia as shown in figures 1–2; first genital segment (VIII) shining beneath, unmodified; proctiger rounded, protruding posteriorly, with lateral tufts of many long setae (Fig. 2). Paramere very long, slender, set with a row of extremely long curved setae (Fig. 1), visible without dissection.

Macropterous male very similar to micropterous male in most respects, but pronotum broader, humeri slightly raised. Hemelytra with usual 4 closed cells, blackish brown, extending beyond tip of abdomen; entire basal angle bright white, extending beyond posterior pronotal margin; without distal white marks; veins lighter basally; inner margin, and broad medial longitudinal stripe, greyish; basally and laterally with long semi-erect setae. Abdominal dorsum with prominent paired longitudinal

carinae on tergite II, lacking in micropterous form; intersegmental sutures along anterior margins of segments II–V broad, becoming narrower posteriorly with successive segment, each with numerous large hair-free pits.

Micropterous female very similar to micropterous male in most respects. Female tergite VIII on same plane as VII, truncate posteriorly, length slightly more than half of VII; first gonocoxae large, plate-like. Legs slightly more slender than male, not fusiform, lacking fore tibial comb. Abdominal pleural region slightly concave and faintly shining on segments V, VI, apparently to aid phoresy.

Macropterous female very similar to winged male in most respects, but slightly larger. Somatic characters as in micropterous female.

Etymology. The name *cavicola* is derived from the Latin “cavus” meaning hollow or hole, and the New Latin “cola” meaning “dwelling in.”

Discussion. *Microvelia cavicola* was discovered in water-filled treeholes on Barro Colorado Island. Specimens were found in natural holes of six tree species, and artificial treeholes constructed of plastic. See the companion article by Yanoviak in this issue for further details.

Distribution. Panama.

Types. Holotype, micropterous ♂, PANAMA, **Canal Zone**, Barro Colorado Island, treehole in *Platypodium elegans*, hole SY96-732, 27.vi.1996, S. Yanoviak (USNM). Paratypes (nymphs not paratypes): Panama, **Canal Zone**, Barro Colorado Island, all collected by S. Yanoviak: 8 micropterous ♂, 6 macropterous ♂, 1 micropterous ♀, 14 macropterous ♀, same data as holotype; 1 macropterous ♀, treehole in *Platypodium elegans*, hole SY96-745, 26.v.1996; 1 macropterous ♂, 1 macropterous ♀, same, except hole OMF-84, 31.v.1996; 3 micropterous ♂, 5 macropterous ♂, 2 micropterous ♀, 10 macropterous ♀, 2 nymphs, same, except hole SY96-539, 11.vii.1996; 2 macropterous ♀, same, except hole SY96-760, 25.vii.1996; 1 macropterous ♂, 2 macropterous ♀, 2 nymphs, treehole in *Ficus* sp., hole SY96-729, 14.vi.1996; 2 macropterous ♂, 2 micropterous ♀, same, except hole SY96-729, 31.v.1996; 2 micropterous ♂, 8 micropterous ♀, 6 nymphs, same, except hole SY96-716, 1.viii.1996; 5 macropterous ♂, 2 nymphs, treehole in *Dipteryx panamensis*, hole #90, 0.1 m above ground, 24.v.1996; 1 macropterous ♂, hole #92, same except 0.2 m above ground; 1 macropterous ♀, 1 nymph, hole #93, same except 0.9 m above ground; 4 micropterous ♂, 3 macropterous ♂, 5 micropterous ♀, 1 macropterous ♀, 4 nymphs, treehole in *Pseudobombax septenatum*, hole SY96-743, 9.vii.1996; 5 micropterous ♂, 5 macropterous ♂, 17 macropterous ♀, 1 nymph, treehole in *Alseis blackiana*, hole SY96-532, 25.v.1996; 3 macropterous ♂, 1 micropterous ♀, 5 macropterous ♀, same, except hole SY96-532, 8.vii.1996; 9 micropterous ♂, 2 macropterous ♂, 6 micropterous ♀, 2 macropterous ♀, 3 nymphs, treehole (unknown tree sp.), hole SY96-539, 27.v.1996; 1 macropterous ♂, 2 macropterous ♀, same, except hole OMF-47, 26.v.1996; 3 macropterous ♂, same, except hole OMF-65, 26.v.1996; 2 macropterous ♂, 6 macropterous ♀, artificial treehole (R2UF), 23.x.1995 (JTPC, USNM, AMNH, ZMUC, SYC).

Microvelia karunaratnei, new species

Figs. 3–5

Diagnosis. *Microvelia karunaratnei* sp. n. is similar in most respects to species of the New World *Microvelia laesslei* group (see characterization of the *M. laesslei*

group under *M. cavicola* above), but differs in having a bright white spot in the medial cell of each hemelytron, a characteristic of species belonging to *Microvelia* s. str. The modified middle and hind femora separate *M. karunaratnei* from all other *Microvelia* species except *M. ancona*; these two species are unique in the genus in having the middle and hind femora fusiform, ventrally set with short spines (along with the usual longer setae) and a small tumescence or spur.

Description. *Size.* Micropterous male, length 2.44 mm (N = 1); width 0.89 mm (N = 1). Micropterous female, length 2.89 mm (N = 2); width 1.05 mm (N = 2). Macropterous male, length 2.66 mm (N = 1); width 1.22 mm (N = 1). Macropterous female, length 2.50–2.83 mm (mean = 2.69 mm, N = 4); width 1.00–1.17 mm (mean = 1.12 mm, N = 4).

Color. Ground color dark brown tinged with rufous; venter similar, but lighter. Head brown, tinged with rufous, light brown ventrally; rostrum fuscous on basal three segments, piceous distally. Pronotum with anterior lobe orange brown medially, darkening laterally; collar very narrow, brown, disc dark brown, slightly lighter laterally. Abdominal tergites dark brown; tergite VII, connexiva brown. Wing pads bright white, with a row of ca. 7 dark setae along outer margin. Legs, antennae testaceous to brown; antennal segments III, IV lighter.

Micropterous male with head of moderate length, declivant anteriorly; length 0.35; eyes small, width of eye/interocular space, 0.10/0.37. Pronotum long, extending over base of abdominal tergite II (first visible tergite), humeri not prominent; disc set with numerous small foveae; length:width, 0.60: 0.86. Wing pads narrowly rounded posteriorly, tips not surpassing posterior margin of pronotum. Abdominal tergites II–VI subequal in length (0.16), VII longest (0.26); intersegmental suture between II–III, III–IV narrow, with numerous hair-free pits; tergites V–VII with a median hair-free longitudinal stripe on midline finely rugulose, shining. Entire dorsum set with fine pubescence, appearing golden in certain light angles, longer on tergites II–IV. Connexiva moderately raised, tapering evenly along tergite VII, posterolateral angles of abdomen set with a few longer setae directed caudad.

Mesosternum, metasternum slightly tumid, posterior margin of mesosternum with a pair of posteriorly directed tubercles, one on either side of midline, in contact with metasternum. Abdominal venter set with short appressed setae, slightly longer laterally and caudally; ventrite VII unmodified, posterior margin slightly concave. Legs clothed with short setae intermixed with sparse longer setae; antennae set with short setae and scattered longer setae. Legs modified; mid and hind femora thickened basally, abruptly narrowed at distal $\frac{2}{3}$, there with a small ventral patch of dark setae (Figs. 4, 5); all femora weakly fusiform; all tibia straight, anterior tibia with short ventral comb, $\frac{1}{6}$ of tibial length. Claws, arolia normal, slender.

Antennal segments I, II stout, III, IV long, slender; formula I:II:III:IV; 0.26: 0.67: 0.35: 0.47.

Proportions of legs as follows: Femur, tibia, tarsal 1, tarsal 2 of fore leg, 0.67: 0.55: 0.28: 0.0; of middle leg, 0.77: 0.72: 0.12: 0.23; of hind leg, 0.88: 0.86: 0.14: 0.26.

Abdominal terminalia unmodified; first genital segment shining beneath; tergite IX rounded, protruding posteriorly. Paramere curved, broad, blade-like, narrowly acuminate distally, without long setae (fig. 3), not visible without dissection.

Macropterous male very similar to micropterous male in most respects, but pro-

notum broader, humeri slightly raised. Hemelytra brown, extending beyond tip of abdomen, with usual 4 closed cells, plus a fifth distal cell open posteriorly; basal angle bright white, extending to or slightly beyond posterior pronotal margin, in the shape of an obtuse triangle, with inner posterior margin angled cephalad; inner distal closed (medial) cell with an elongate white streak; distally with a long wedge-shaped white mark widening posteriorly, usually reaching apex of wing or nearly so; outer distal closed cell sometimes with a faint light spot medially; margin of wing light colored, except costal margin; basally and laterally with moderately long semi-erect setae. Abdominal dorsum under wings not examined.

Micropterous female very similar to micropterous male in most respects. Wing pads broadly to narrowly rounded behind, reaching to or slightly beyond posterior margin of pronotum. Female tergite VIII on same plane as VII, truncate posteriorly, length slightly more than half of VII; first gonocoxae large, plate-like. Legs very similar to male, similarly modified, lacking fore tibial comb.

Macropterous female very similar to winged male in most respects, but slightly larger. Somatic characters as in micropterous female.

Etymology. The name *karunaratnei* honors the late P. B. Karunaratne. Karu, as he was fondly known, made many fine contributions to the knowledge of all aspects of the natural history of Sri Lanka, but especially the aquatic and semiaquatic Heteroptera.

Discussion. All specimens were collected in tree rotholes about 2 m above the ground. Nothing more is known about the ecology of this species.

Distribution. Sri Lanka.

Types. Holotype, macropterous ♂, SRI LANKA, Padukka, Arakawila Jungle, ex. rot hole filled with rain water on tree trunk 5 ft. above ground, 8.viii.1971, P. B. Karunaratne (USNM). Paratypes: SRI LANKA: 2 macropterous ♀, same data as holotype (USNM); 1 micropterous ♂, 2 macropterous ♀, same data as holotype except 15.vi.1971 (JTPC, USNM); 2 micropterous ♀, Kandy, Reservoir Jungle, ex. rain water filled rot hole in tree trunk, Ht. 5 ft., 4.iii.1972, P. B. Karunaratne (JTPC, USNM). (A note with the specimens, in Karunaratne's handwriting, concerning the holotype locality states "From this same rot hole 8 specimens were collected on the 1st April 1971 and 8.viii.1971." As there are only three specimens from these collections in the material presented by Karunaratne, there should be 5 more specimens in the National Museum of Sri Lanka (CNMS), and they are considered paratypes.)

Paravelia myersi, Hungerford

Velia myersi Hungerford 1931:172. (Holotype, macropterous male, Trinidad, tree-hole, BMNH.)

Paravelia myersi Polhemus 1976:512.

Discussion. A number of specimens of this species were found by Yanoviak during his study of the fauna of treeholes in Panama. Previously *P. myersi* was known only from Trinidad, thus Panama is a considerable range extension. This raises the possibility that *Paravelia atra* (Polhemus, 1969) from Peru is a synonym; although the latter is known only from a single male without habitat data, the male parameres are very similar. A series of specimens from Peru will be needed to settle this question.

Material examined (all specimens macropterous). PANAMA, **Canal Zone**, Barro Colorado Island, all collected by S. Yanoviak: 1 ♀, treehole in *Platypodium elegans*, hole SY96-620, 10.vi.1996; 1 ♂, 1 nymph, treehole in *Pseudobombax septenatum*, hole SY96-743, 9.vii.1996; 1 nymph, treehole (unknown tree sp.), hole OMF-12, 9.vii.1996; 1 nymph, same, except hole OMF-3, 20.vi.1996; 2 ♀, artificial treehole (R5MC), 6.vii.1996; 1 ♂, same, except hole (RICF), 1.viii.1996; 1 ♂, same, except hole (R6CF), 3.vi.1995; 2 ♀, same, except hole (insectary SY-803), 11.vi.1996 (JTPC). TRINIDAD: 1 ♂, 2 ♀, T.210, 24.i.1929, I. H. Myers (JTPC).

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JTP carried out this research as a faculty affiliate of the Entomology Department, Colorado State University, Fort Collins.

LITERATURE CITED

- Drake, C. J., 1952. Two new *Microvelia* Westwood (Hemiptera: Veliidae). Bull. Brooklyn Entomol. Soc. 47:13–15.
- Hungerford, H. B., 1931. A new *Velia* from Trinidad (Hemiptera, Veliidae). Ann. Mag. Nat. Hist. (10) 7:172–175.
- Laird, M. 1956. Studies of mosquitoes and freshwater ecology in the South Pacific. R. Soc. New Zealand, Bull. No. 6:1–213.
- Polhemus, J. T. 1969. A new *Velia* from Peru, and the description of the male of *Velia helenae* Hungerford (Hemiptera: Veliidae). Proc. Entomol. Soc. Wash. 71:55–58.
- Polhemus, J. T. 1976. A reconsideration of the status of the genus *Paravelia* Breddin, with other notes and a check list of species (Veliidae: Heteroptera). J. Kansas Entomol. Soc. 49:509–513.
- Polhemus, J. T. and R. S. Copeland, 1996. A new genus of Microveliinae from treeholes in Kenya (Heteroptera: Veliidae). Tijdschr. Entomol. 139:73–77.
- Polhemus, J. T. and C. L. Hogue, 1972. Two new *Microvelia* from crabholes in Costa Rica (Hemiptera: Veliidae). Los Angeles Co. Mus. Nat. Hist., Contr. Sci., No. 224, pp. 1–6.
- Polhemus, J. T. and D. A. Polhemus, 1991. A review of the veliid fauna of bromeliads, with a key and description of a new species (Heteroptera: Veliidae). J. New York Entomol. Soc. 99:204–216.
- Yang, C. M. and Kovac, D. 1995. A collection of aquatic and semi-aquatic bugs (Insecta: Hemiptera: Gerromorpha and Nepomorpha) from Temengor Forest Reserve, Hulu Perak, Malaysia. Malayan Nature J. 48:287–295.

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DISTRIBUTION AND ABUNDANCE OF *MICROVELIA CAVICOLA* POLHEMUS (HETEROPTERA: VELIIDAE) ON BARRO COLORADO ISLAND, PANAMA

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Abstract.—Data and observations from 1995, 1996 and 1997 wet season surveys of natural and artificial tree holes suggest that hole morphology and size are important predictors of the distribution and abundance of *Microvelia cavicola* Polhemus. The bugs occurred in 42% of the natural holes sampled and <3% of artificial hole censuses. The distribution of *M. cavicola* was not associated with holes in particular tree species or with hole height above the ground. Abundance increased with hole size and decreased with hole height. Analyses of presence/absence data showed significant within- and between-year microhabitat fidelity in this species. *Microvelia cavicola* reduced the emergence success of mosquitoes in a laboratory experiment, but their quantitative effect on mosquitoes in natural conditions is unknown.

INTRODUCTION

Tree holes are phytotelmata (i.e., plant-held water) formed by the collection of rainfall in rot holes or other cavities in the woody portions of trees (e.g., Kitching, 1971). A variety of macroorganisms use tree holes as breeding sites, and more than 50 invertebrate species are directly or indirectly associated with water-filled tree holes in Panama (Yanoviak, 1999a). The behavior and ecology of some of these taxa, such as odonates (Fincke, 1992a, 1992b, 1994, 1998) and mosquitoes (Galindo et al., 1950, 1951, 1955) are well documented. Aside from Snow's (1949) work in Guatemala, relatively little is known about the biology of the many other invertebrates that use this habitat.

Numerous biotic factors, including predation (e.g., Bradshaw and Holzapfel, 1983), competition (e.g., Fincke, 1992b; Juliano 1998), and nutrient availability (e.g., Srivastava and Lawton, 1998; Yanoviak, 1999b), may affect the presence or absence of invertebrate species in water-filled tree holes and similar habitats. In Panama, abiotic characteristics of tree holes, such as size, shape, disturbance frequency, and height above the ground additionally influence the distributions of some organisms (Galindo et al., 1951; Fincke, 1998, 1999; Yanoviak, 1999c).

Two genera of neustonic true bugs (Heteroptera: Veliidae), *Microvelia* Westwood and *Paravelia* Breddin, live and breed in neotropical phytotelmata (Drake and Hussey, 1954; Polhemus and Polhemus, 1991), including water-filled tree holes. The goals of this study were to: 1) describe the abundance, local distribution and behavior of a new *Microvelia* species, *M. cavicola* (Polhemus, 1999), discovered in water-filled tree holes of Panama; and 2) determine how the distribution of *M. cavicola* is related to factors such as tree species, hole volume, and hole height above the ground.

METHODS

This study was conducted in the lowland moist forest of Barro Colorado Island (BCI), Panama (see Leigh et al., 1996 and Leigh, 1999 for site description). Tree holes, the only known natural habitat of *M. cavicola*, are common and broadly distributed in the BCI forest. Most holes contain water throughout the wet season (May through December) and many (especially small or exposed holes) dry completely by March (Fincke, 1992b).

All individuals of *M. cavicola* used in this study were collected with an aspirator from the tree hole water surface and interior walls. Live specimens were transported to the laboratory for identification and behavioral observations. Only a portion of the population within a hole was removed on a collection date. Voucher specimens were killed in 80% ethanol, mounted on points, and deposited as allotypes (Polhemus, 1999).

Field. The abundance of *M. cavicola* in artificial and natural tree holes on BCI was recorded during three consecutive wet seasons: May–December 1995, May–August 1996, and July–December 1997. The same artificial holes (0.65 l and 1.5 l black plastic containers tied to trees at three different heights and filled with leaf litter, rain water, and an emergent piece of tree bark) were censused every year as part of a vertical stratification study (Yanoviak, 1999c). Natural holes were censused in a variety of tree species, but most sampled holes were in *Dipteryx panamensis* (Pitt.) Rec. and Mell (Fabaceae; 20%), two free-standing *Ficus* species (*F. insipida* Willd. and *F. yoponensis* Desv.; Moraceae; 16%), *Gustavia superba* (H.B.K.) Berg (Lecythidaceae; 8%), or *Platypodium elegans* J. Vogel (Fabaceae; 28%). Volumes of most of the natural holes were determined by removing water with a turkey baster into a graduated cylinder. Volumes of the largest holes and surface areas for all holes were estimated from dimensions of appropriately shaped polygons. Tree hole height and volume were not correlated ($R = 0.164$, $P = 0.13$, $N = 87$). Volume was used as a measure of overall hole size for analyses because volume and surface area were correlated (1996 natural hole data; $R = 0.803$, $P < 0.0001$, $N = 52$; also see Fincke 1994). Additional methodological details and summaries of tree hole characteristics are presented elsewhere (Yanoviak, 1999a, c).

Host-tree specificity was analyzed with a chi-square test using *M. cavicola* presence/absence data for natural holes in the tree species listed above (*Ficus* spp. pooled for analysis). I only used data from the first occurrence of *M. cavicola* in each hole to prevent pseudoreplication (Hurlbert, 1984) and avoid possible effects of disturbance caused by hole sampling.

During 1996 field surveys, it appeared that a hole containing *M. cavicola* on the first sample date was more likely to contain this species on later sample dates than holes from which it was initially absent. Two separate chi-square analyses were used to address this site fidelity question. The first chi-square tested short term site fidelity with the null hypothesis of no association between presence of the bugs in the first sample of a hole and any of the four subsequent samples (pooled) for the 1996 natural hole data. In the same manner, the second chi-square tested for long term site fidelity among 25 holes sampled in both 1995 and 1996. The expected value for each cell in the contingency tables was the product of presence/absence probabilities determined from the total number of holes sampled in each census period. Data from

1997 censuses were excluded because some holes were frequently disturbed or manipulated for experiments.

Laboratory. I maintained several subpopulations of *M. cavicola* in clear glass or plastic dishes in the laboratory ($24 \pm 0.5^\circ\text{C}$; irregular lighting conditions) for observations of feeding behavior and adult longevity. Each culture dish (ca. 10 cm diam., 1.5 cm deep) was filled to a depth of 0.5 cm with rain water and contained ≤ 30 bugs. Cork disks (10 mm diameter, 2 mm thick) served as perching sites and the dishes were kept covered except during observations. Live food (one dealated tortricid moth per dish) was supplied weekly. I removed prey remains after 24 hr and replaced the dish water every 7–10 d to prevent fungal growth. Lab populations of *M. cavicola* were maintained for up to 60 d before all cultures were terminated.

The effects of *M. cavicola* on mosquito emergence success were determined by placing 10 adult *M. cavicola* starved ≥ 3 d in a plastic cup (8.5 cm height, 5.5 cm diameter) containing 50 ml rain water, a stick perch, and four pupae of the tree hole mosquito *Culex urichii* (Coquillett). Control cups lacked *M. cavicola*. The experiment was replicated seven times, and new predators and prey were used in each replicate. Cups were individually covered with netting (0.5 mm mesh) to prevent escape of veliids and adult mosquitoes. Each cup was checked at least twice daily and the experiment was terminated when all mosquitoes emerged or were dead (ca. 2 d). The average number of mosquitoes surviving to adulthood was compared between treatments with a t-test assuming unequal variance.

RESULTS

Microvelia cavicola was found in 87 (42%) of the 206 different natural holes sampled over the three years. Their presence or absence was not significantly associated with tree species ($\chi^2 = 5.35$, $df = 3$, $P > 0.10$). The bugs occurred in 10 (1.9%) of the 520 artificial hole censuses in 1995, 3 (2.5%) of 120 censuses in 1996, and 3 (1.9%) of 160 censuses in 1997. Their abundance never exceeded 2 individuals per artificial hole.

Half (53%) of the natural holes in which *M. cavicola* was found contained 3 or more individuals. Where the bugs occurred, their mean (\pm SE) abundance was 10.5 ± 1.5 individuals per hole. The average density of *M. cavicola* (individuals per cm^2 surface area) was greater in highly shaded holes (0.13 ± 0.03 ; $N = 29$) than in more exposed holes (0.03 ± 0.01 ; $N = 25$, $t = 2.66$, $P = 0.01$). The largest number of individuals recorded in a census (70) occurred in a large, shaded, pan-shaped hole in the base of a mature *Pseudobombax septenatum* (Jacq.) Dug. (Bombacaceae).

Adults and immatures of *M. cavicola* were found at all heights and in all size classes of holes censused except those < 100 ml in volume (Fig. 1). Natural holes containing *M. cavicola* were larger than holes lacking the bugs ($t = 5.86$, $P < 0.0001$). Abundance of *M. cavicola* in natural holes increased with hole volume and weakly declined with hole height (Fig. 1, Table 1). However, exclusion of data from holes > 17 m above the ground ($N = 4$) nullified the significant slope of the height-abundance relationship ($t = -1.70$, $P > 0.05$).

Of the 43 natural holes repeatedly sampled in 1996, 15 (35%) contained one or more bugs on the first sample date and 22 (51%) never contained *M. cavicola*. The association between their presence in a hole on the first sample date and any sub-

Table 1. Multiple regression output for effects of tree hole volume and height on *Microvelia cavicola* abundance. N = 87 natural holes containing one or more individuals. Data were log-transformed before analysis to correct variance heterogeneity (Sokal & Rohlf 1981). Model: $F_{2,84} = 20.02$, $P = 0.0001$, $R^2 = 0.323$. ** = $P < 0.01$

Variable	Estimate	SE	t
y-intercept	-1.324	0.334	-3.97**
Height	-0.221	0.074	-2.97**
Volume	0.656	0.109	6.00**

sequent sample date was significantly different from random ($\chi^2 = 10.95$, $df = 1$, $P < 0.001$). Of the 25 natural holes censused in both 1995 and 1996, 11 contained *Microvelia* in 1995. Nine (82%) of these 11 again contained *M. cavicola* in 1996. This association was also significantly different from random ($\chi^2 = 15.62$, $df = 1$, $P < 0.001$).

Mosquito emergence success was significantly reduced by *M. cavicola* in the laboratory-based predation experiment (Fig. 2). The density of veliids used in the experiment (0.42 cm^{-2} surface area) was greater than the mean ($\pm \text{SE}$) density for small natural holes (area $< 200 \text{ cm}^2$; 0.14 ± 0.04 , $N = 15$), but was still less than the maximum density (0.46 cm^{-2}) of *M. cavicola* observed in the field. This artificially high predator abundance was balanced by the experimental prey density (0.08 ml^{-1}), which was greater than the average mosquito density (0.02 ± 0.006 ; $N = 15$, including larvae and pupae) observed in small natural holes.

Examination of mosquito remains indicated that most were attacked shortly after exposure of the thorax during emergence. On several occasions, I observed *M. cavicola* probing the thoracic horns of mosquito pupae visiting the surface, and in every case the pupae responded by immediately descending into the water column. Six pupae in the predator treatment (none in controls) were found dead with no evidence of an emergence attempt.

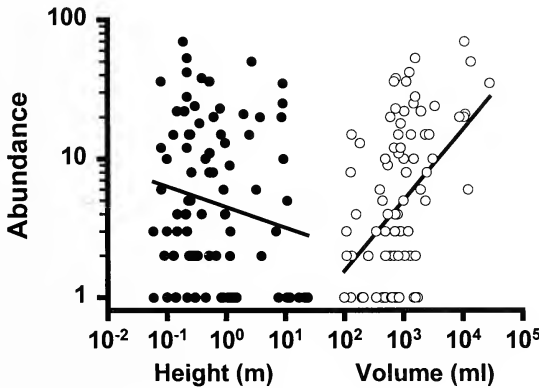


Fig. 1. Effect of tree hole height (filled circles) and volume (open circles) on *Microvelia cavicola* abundance in the 87 natural holes where it occurred. Mean ($\pm \text{SE}$) height = 2.6 ± 0.5 m and volume = 1992 ± 425 ml.

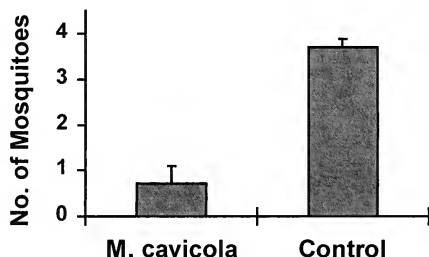


Fig. 2. Mean (+SE) number of mosquitoes successfully emerging from cups containing *M. cavicola* and control cups lacking *M. cavicola*. $t = 8.82$, $df = 10$, $P < 0.001$

In field and lab feeding trials, *M. cavicola* rapidly attacked prey struggling in the surface film. Prey were quickly subdued and their activity typically stopped <1 min after arrival of the first bug. In the lab, more than 20 *M. cavicola* were observed to feed simultaneously on a single moth by initially aggregating side to side and then climbing over one another as foraging space became limited. The last few individuals to arrive at a prey item were often denied access by interference from those already feeding. Although aggressive interactions among individuals were frequent in the lab and the field, there was no evidence of cannibalism, even during prolonged periods (i.e., >10 d) of food limitation. Only one of the >200 *M. cavicola* kept in captivity died during the 60 d study period.

DISCUSSION

Hole morphology, exposure, and size appear to be important factors limiting the distribution of *M. cavicola* in the BCI forest. Their greatest density occurred in slit-type natural holes (see Fincke, 1992b for classification) or bowl-type holes with steep sides and a shaded or concealed water surface. The low occurrence (and abundance) of veliids in artificial tree holes was probably because the water surface in the containers was more exposed than in natural holes. Where *M. cavicola* did occur, its abundance increased with hole size (Fig. 1). Mosquitoes, which are potential prey for veliids (Frick, 1949; this study), also tend to increase in abundance with hole volume (e.g., Lounibos, 1983). Although larger holes are often more exposed, the greater (in absolute terms) availability of prey and spatial resources probably facilitates the coexistence of large numbers of *M. cavicola*, which interact aggressively when food is scarce.

The distribution of *M. cavicola* in the BCI forest differs markedly from that of the Old World veliid *Cylicovelia kenyana* Polhemus and Copeland, the only other tropical tree hole species for which local occurrence and abundance data have been collected. Polhemus and Copeland (1996) found a significant positive association between hole height and the presence of *C. kenyana*, but only sampled holes to a maximum height of 6.4 m. My results showed a weak negative relationship between tree hole height and *M. cavicola* abundance on BCI. *Cylicovelia kenyana* also differs from *M. cavicola* in that it does not occur in shaded tree holes and its presence or absence is independent of hole volume (Polhemus and Copeland, 1996).

There are at least two explanations for the short-term and long-term site fidelity

exhibited by *M. cavicola* in BCI tree holes. First, the bugs may be highly microsite-selective both within and between years such that consistency in their occurrence reflects non-random annual recolonization of "preferred" holes. A second possibility is that current *M. cavicola* distributions represent many years of population persistence in certain holes, i.e., holes that are sufficiently large or sheltered to resist complete drying. The local distribution of *M. cavicola* is probably limited by both availability of suitable tree holes and habitat disturbance frequency, but detailed investigations of dispersal, colonization, and possible dry season diapause are needed to determine the degree to which each of these (or other) explanations are applicable.

The feeding behavior of *M. cavicola* is similar to that described for other members of the genus (Bueno, 1910, 1917; Frick, 1949; Travers, 1993). Adult mosquitoes and other mobile insects visiting tree holes (e.g., to oviposit) are not typically eaten by *M. cavicola* (pers. obs.); the most common sources of food appear to be dead and dying invertebrates that become trapped in the water surface film (Bueno, 1910, 1917), and insects in the process of emerging from the water. The rapid and direct movement of *M. cavicola* to struggling prey suggests that they locate food by detecting water surface vibrations (Travers, 1993). Although not observed in this study, Hoffmann (1924) noted that *Microvelia* can also capture prey occurring just beneath the water surface. This sort of predation may explain the apparent drowning deaths of mosquito pupae in the lab experiment. The effect of *M. cavicola* on mosquito survivorship under completely natural circumstances is not known, but may be important when abundance of the bugs in a hole is high relative to mosquito abundance.

Growth rates of *M. cavicola* in the lab were similar to those described for temperate (Bueno, 1910, 1917) and tropical (Frick, 1949) congeners (pers. obs.). The longevity of individuals in the lab suggests that ≥ 2 generations are produced each wet season and that adults are relatively long-lived.

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LITERATURE CITED

- Bradshaw, W. E. and C. M. Holzapfel. 1983. Predator-mediated, non-equilibrium coexistence of tree-hole mosquitoes in southeastern North America. *Oecologia* 57:239–256.
- Bueno, J. R. T. 1910. Life-histories of North American water-bugs.—III. *Can. Entomol.* 42: 176–186.
- Bueno, J. R. T. 1917. Life history of the northern *Microvelia*—*Microvelia borealis* Bueno (Hem., Het.). *Entomol. News* 28:354–359.
- Drake, C. J. and R. F. Hussey. 1954. Notes on some American Veliidae (Hemiptera), with the description of two new *Microvelias* from Jamaica. *Florida Entomol.* 37:133–138.
- Fincke, O. M. 1992a. Behavioural ecology of the giant damselflies of Barro Colorado Island, Panama. In Quintero, D. and A. Aiello, eds. *Insects of Panama and Mesoamerica*. Oxford Univ. Press, Oxford. pp. 102–113.

- Fincke, O. M. 1992b. Interspecific competition for tree holes: consequences for mating systems and coexistence in neotropical damselflies. *Am. Nat.* 139:80–101.
- Fincke, O. M. 1994. Population regulation of a tropical damselfly in the larval stage by food limitation, cannibalism, intraguild predation and habitat drying. *Oecologia* 100:118–127.
- Fincke, O. M. 1998. The population ecology of *Megaloprepus coerulatus* and its effect on species assemblages in water-filled tree holes. In Dempster, J. P. and I. F. G. McLean, eds. *Insect populations in theory and in practice*. Kluwer Academic, Dordrecht. pp. 391–416.
- Fincke, O. M. 1999. Organization of predator assemblages in Neotropical tree holes: effects of abiotic factors and priority. *Ecol. Entomol.* 24:13–23.
- Frick, K. E. 1949. The biology of *Microvelia capitata* Guérin, 1857, in the Panama Canal Zone and its role as a predator on anopheline larvae (Veliidae: Hemiptera). *Ann. Entomol. Soc. Am.* 42:77–100.
- Galindo, P., S. J. Carpenter and H. Trapido. 1951. Ecological observations on forest mosquitoes of an endemic yellow fever area in Panama. *Am. J. Trop. Med.* 31:98–137.
- Galindo, P., S. J. Carpenter and H. Trapido. 1955. A contribution to the ecology and biology of tree hole breeding mosquitoes of Panama. *Ann. Entomol. Soc. Am.* 48:158–164.
- Galindo, P., H. Trapido and S. J. Carpenter. 1950. Observations on diurnal forest mosquitoes in relation to sylvan yellow fever in Panama. *Am. J. Trop. Med.* 30:533–574.
- Hoffmann, W. E. 1924. Winter food for waterbugs in aquaria. *Bull. Brooklyn Entomol. Soc.* 19:149–150.
- Hurlbert, S. H. 1984. Pseudoreplication and the design of ecological field experiments. *Ecol. Mongr.* 54:187–211.
- Juliano, S. A. 1998. Species introduction and replacement among mosquitoes: interspecific resource competition or apparent competition? *Ecology* 79:255–268.
- Kitching, R. L. 1971. An ecological study of water-filled tree-holes and their position in the woodland ecosystem. *J. Anim. Ecol.* 40:281–302.
- Leigh, E. G., Jr. 1999. *Tropical forest ecology: a view from Barro Colorado Island*. Oxford Univ. Press, New York.
- Leigh, E. G., Jr. A. S. Rand and D. M. Windsor, eds. 1996. *The ecology of a tropical forest*, 2nd Edition. Smithsonian Inst., Washington, DC.
- Lounibos, L. P. 1983. The mosquito community of treeholes in subtropical Florida. In Frank, J. H. and L. P. Lounibos, eds. *Phytotelmata: terrestrial plants as hosts for aquatic insect communities*. Plexus, Medford, NJ. pp. 223–246.
- Polhemus, J. T. 1999. Two new species of *Microvelia* from treeholes, with notes on other container-inhabiting veliid species (Heteroptera: Veliidae). *J. New York Entomol. Soc.* 107:31–37.
- Polhemus, J. T. and R. S. Copeland. 1996. A new genus of Microveliinae from treeholes in Kenya (Heteroptera: Veliidae). *Tijds. Entomol.* 139:73–77.
- Polhemus, J. T. and D. A. Polhemus. 1991. A review of the veliid fauna of bromeliads, with a key and description of a new species. *J. New York Entomol. Soc.* 99:204–216.
- Snow, W. E. 1949. The arthropoda of wet tree holes. Ph.D. dissertation. Univ. Illinois, Urbana.
- Sokal, R. R. and F. J. Rohlf. 1981. *Biometry*. W. H. Freeman & Co., New York.
- Srivastava, D. S. and J. H. Lawton. 1998. Why more productive sites have more species: experimental test of theory using tree-hole communities. *Am. Nat.* 152:510–529.
- Travers, S. E. 1993. Group foraging facilitates food finding in a semi-aquatic hemipteran, *Microvelia australis* Bueno (Hemiptera: Veliidae). *Pan-Pac. Entomol.* 69:117–121.
- Yanoviak, S. P. 1999a. Community ecology of water-filled tree holes in Panama. Ph.D. dissertation, Univ. Oklahoma, Norman.

- Yanoviak, S. P. 1999b. Effects of leaf litter species on macroinvertebrate community properties and mosquito yield in neotropical tree hole microcosms. *Oecologia* (in press)
- Yanoviak, S. P. 1999c. Community structure in water-filled tree holes of Panama: effects of hole height and size. *Selbyana* (in press)

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A REVIEW OF THE LEAFHOPPER GENUS *NIELSONIA* YOUNG WITH DESCRIPTIONS OF NEW SPECIES (HOMOPTERA: CICADELLIDAE: CICADELLINAE)

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Abstract.—The genus *Nielsonia* was established by Young (1977) and included four new species: *praestigia*, *pretensa*, *scissa* and *rostris*. In this paper we describe three new species from Costa Rica: *serrata*, *unica*, and *pucketti*, the latter also present in Honduras and Panamá. A revised key to all known species, based on male genitalia, is also presented. The genus ranges from Honduras (new northern record) to Ecuador.

The genus *Nielsonia* was described and illustrated by Young (1977), who described four species: *praestigia*, *pretensa*, *scissa* and *rostris*. The latter was reported from Costa Rica with an altitudinal range of 1000 to 1600 meters; the other three species are found in Panama and *scissa* is also reported from Ecuador. In this paper we describe three new species from Costa Rica: *serrata*, *unica*, and *pucketti*. The latter is also present in Honduras and Panama, this being the first record of the genus from Honduras. Very little is known about the biology of these leafhoppers.

Nielsonia Young, 1977

Nielsonia Young, 1977. Type-species *Nielsonia praestigia* Young, 1977.

Color. Mustard yellow, with black spots or lines on the dorsum of the head; pronotum with two spots.

Male genitalia. Pygofer not strongly produced, posterior margin varying from slightly convex to shallowly concave, pygofer processes present or absent; connective broadly U- or Y-shaped; aedeagus asymmetrical with an unpaired basal process, basal apodemes greatly elongate.

Young (1977) described the female sternum VII as being moderately produced posteriorly, with the posterior margin obtusely angular or subangular. However, one of the new species described below, *N. unica*, has the posterior margin regularly and slightly concave.

MATERIAL AND METHODS

We followed Oman's (1949) method of preparing leafhopper genitalia for dissections and study, with the following modification. Each abdomen was placed separately in 10% potassium hydroxide overnight at room temperature instead of being heated. The following day we washed the genitalia for five minutes in water.

Material examined: Holotypes (all USNM) of *Nielsonia praestigia* Young, *N. pretensa* Young, *N. rostri* Young, *N. scissa* Young.

Specimens are deposited in the following collections:
CAS: California Academy of Sciences, San Francisco, USA.
INBio: Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica.
NHM: The Natural History Museum, London, UK.
UCR: University of Costa Rica, San Pedro, San José, Costa Rica.
USNM: United States National Museum, Washington, USA.
USU: Utah State University, Logan, USA.
ZEAP: Zamorano Escuela Agrícola Panamericana, Tegucigalpa, Honduras.

KEY TO MALES OF *NIELSONIA*

- 1. Pygofer with short posterior process directed ventrally 2
- Pygofer with short posterior process directed dorsally (Fig. 23) *pretensa* Young
- 2. Ventral aedeagal process with smaller lateral process near midlength (Fig. 24) 3
- Ventral aedeagal process without lateral process 5
- 3. Small lateral aedeagal process oriented perpendicular to the main ventral aedeagal process, the latter not bifurcate (Fig. 24) *rostris* Young
- Small lateral aedeagal process oriented more or less parallel to the main ventral aedeagal process, the latter bifurcate or not 4
- 4. Main ventral aedeagal process bifurcate basally (Figs. 14, 15); pygofer with posterior dorsal margin slightly concave (Fig. 10) *unica* n. sp.
- Main ventral aedeagal process not bifurcate basally (Fig. 25); pygofer with posterior dorsal margin slightly convex (Fig. 26) *scissa* Young
- 5. Pygofer with posterior process sclerotized (Fig. 17) *pucketti* n. sp.
- Pygofer with posterior process unsclerotized (Fig. 28) 6
- 6. Aedeagal process with serrate flange (Fig. 7); pygofer with posterior dorsal margin slightly concave (Fig. 2) *serrata* n. sp.
- Aedeagal process without serrate flange (Fig. 27); pygofer with posterior dorsal margin convex (Fig. 28) *praestigia* Young

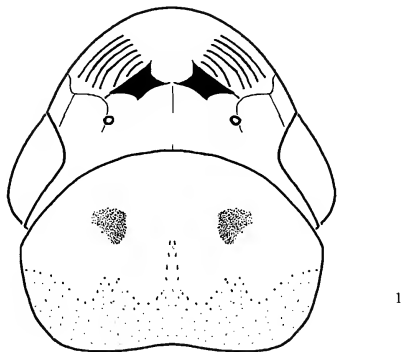
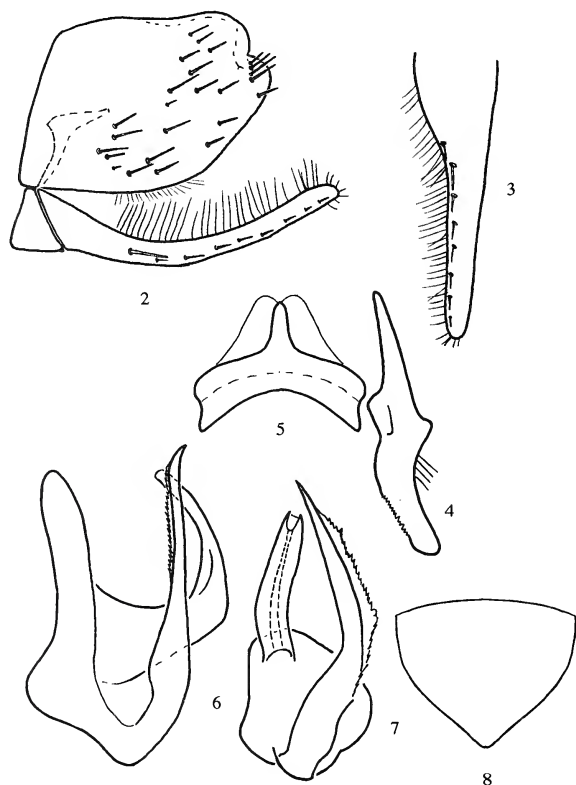


Fig. 1. *Nielsonia serrata*, n. sp.: Anterior dorsum (head and pronotum).



Figs. 2–8. *Nielsonia serrata*, n. sp.: 2. Pygofer, lateral view; 3. Plate, ventral view; 4. Style dorsal view; 5. Connective dorsal view; 6. Aedeagus, lateral view; 7. Aedeagus, caudoventral view; 8. Female abdominal sternum VII.

***Nielsonia serrata*, new species**
(Figs 1–8)

Description. *Length.* Male 8.4–9.3 mm, female 8.5–9.5 mm.

Color. Crown except at apex, pronotum and scutellum, dull brown yellow; apex of crown, posterior two-thirds of pronotum tan, with a pair of angulate black spots on crown (Fig. 1); pair of round black spots on the pronotum before its midlength; pair of subangular black spots at base of scutellum and black spot before its apex; clypeus nearly entirely black, sometimes brown; legs tan, with forewings and often posterior portion of pronotum darker brown.

Head. Moderately produced, anterior margin broadly rounded in dorsal view, without carina at transition from crown to face, ocelli located slightly behind line between anterior eye angle (Fig. 1), clypeus slightly flattened, clypellus weakly pubescent apically.

Thorax. Pronotal width less than transocular width of head, lateral margins parallel anteriorly. Forewings with membrane including almost all of apical cells, texture

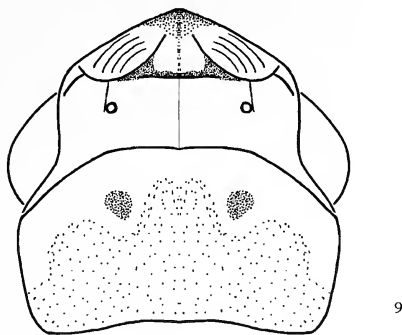


Fig. 9. *Nielsonia unica*, n. sp.: Anterior dorsum (head and pronotum).

coriaceous. Hindlegs with femoral setal formula 2:1:1, length of first tarsomere slightly longer than combined length of second and third tarsomeres.

Male genitalia. Pygofer with posterior margin very slightly concave below apex, with short dorsal unsclerotized process directed posteriorly but not attaining apex of pygofer (Fig. 2); plates narrowly triangular (Fig. 3), extending posteriorly beyond apex of pygofer, with uniseriate macrosetae; style extending beyond apex of connective, without apical lobe (Fig. 4); connective Y-shaped (Fig. 5); aedeagus asymmetrical, with base of shaft separated basally from ventral process, which is curved dorsally close to shaft in lateral view (Fig. 6), in caudoventral view ventral process extending dorsally parallel to shaft, narrowed in its apical half, acuminate and with serrate flange dorsally (Fig. 7).

Female. Abdominal sternum VII with posterior margin produced posteriorly with subangular apex (Fig. 8).

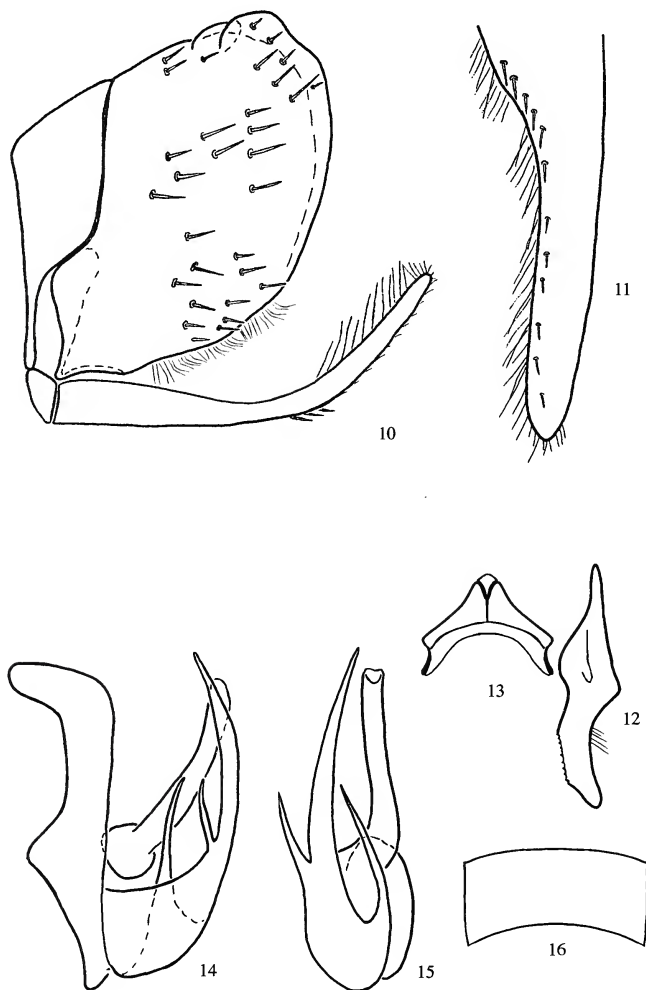
Discussion. *N. serrata* resembles *N. praestigia* but differs in the form of the ventral aedeagal process, the former having a serrate flange. This species has been collected from 650 to 700 meters altitude.

Types. Holotype, ♂, COSTA RICA, **Guanacaste**, Estación Pitilla, 700 m., 9 Km. S Sta Cecilia, II curso Parataxón, v.1990, L-N 330200–380200 (INBio). Paratypes: COSTA RICA, **Guanacaste**: 10 ♂, 2 ♀♀, same data as holotype (7 INBio, 1 CAS, 1 NHM, 1 UCR, 1 USNM, 1 USU); following specimens same data except as noted: 1♂, 1 ♀, v.1988; 1 ♂, 2 ♀♀, 21.iii–21.iv.1989; 1 ♂, vii.1988; 1 ♂, iii.1989; 2 ♂♂, x.1994, C. Moraga; 1 ♂, 19.v–3.vi.1993; 3 ♂♂, 4–23.iv.1995; 1 ♂, xii.1994, P. Rios. **Alajuela**: 1 ♂, Cerro Campana, E. side Volcán Cacao, 6 Km NW Dos Rios, 650 m., 15.vi.1988, Janzen & Hallwachs (all in INBio).

***Nielsonia unica*, new species**
(Figs 9–16)

Description. *Length.* Male 8.5–10.5 mm., female 9–9.5 mm.

Color. Crown except at apex, apex of pronotum and scutellum, yellow; apex of crown, posterior two-thirds of pronotum brown, with an arcuate black line on each side of crown (Fig. 9); a pair of round black spots on disk of pronotum before its



Figs. 10-16. *Nielsonia unica*, n. sp.: 10. Pygofer, lateral view; 11. Plate, ventral view; 12. Style dorsal view; 13. Connective dorsal view; 14. Aedeagus, lateral view; 15. Aedeagus, caudoventral view; 16. Female abdominal sternum VII.

midlength, apex sometimes beige or with a dark pair of subangular black spots on base of scutellum and a black spot before its apex; front black to dark brown; legs yellowish tan to light orange with forewings darker brown. Head and thorax as in *N. serrata*.

Male genitalia. Pygofer with posterior margin slightly concave with short dorsal unsclerotized process directed posteriorly but not attaining apex of pygofer (Fig. 10); plates narrowly triangular, extending posteriorly beyond apex of pygofer, with uniseriate macrosetae (Fig. 11); style extending farther posteriorly than apex of con-

nective, without apical lobe (Fig. 12); connective Y-shaped (Fig. 13); aedeagus asymmetrical, with shaft closely associated with ventral aedeagal process, shaft weakly curved dorsally, ventral process bifurcate, one branch slightly curved dorsally close to shaft in lateral view (Fig. 14); aedeagus in caudoventral view acuminate and bearing short straight acute process at its midlength, and with another longer process basally (Fig. 15).

Female. Abdominal sternum VII with posterior margin regularly and slightly concave (Fig. 16).

Discussion. *N. unica* resembles *N. rostris* but differs in the form of the ventral process, which is bifurcate and has a short branch in *N. unica*. This species has been collected from 600 to 700 meters altitude.

Types. Holotype, ♂, COSTA RICA, **Alajuela**, Fca. San Gabriel 2 Km SW Dos Rios, 600 m. v.1989 GNP Biodiv. Survey 318800, 383500 (INBio). Paratypes: COSTA RICA, **Alajuela**: 11 ♂♂, same data as holotype (6 INBio, 1 CAS, 1 NHM, 1 UCR, 1 USNM, 1 USU); following specimens same data except as noted: 3 ♂♂, vi.1989; 2 ♂♂, v.1990, II curso parataxónomos. **Guanacaste**: 6 ♂♂, 2 ♀♀: Estación Pitilla, 9 Km. S Sta Cecilia, 700 m., 19.v.-3.vi.1993, C. Moraga, L-N 330200–380200; following specimens same data except as noted: 1 ♂, 18–23.vii.1993; 1 ♂, vi.1993; 1 ♂, vi.1994; 1 ♂; x.1994; 1 ♂, ii.1995; 7 ♂♂, v.1988; 1 ♂, vii.1988; 1 ♂, 1 ♀, ix.1988; 3 ♂♂, 2 ♀♀, xi.1988; 9 ♂♂, 21.iii–21.iv.1989; 13 ♂♂, 2 ♀♀, II curso parataxonomos, iv.1990; 2 ♂♂, 4–23.iv. 1995, M. Moraga; 2 ♂♂, same date, E. Alfaro; 6 ♂♂, ii.1995, P. Ríos; 1 ♂, xii.1989; 3 ♂♂, 1 ♀, vi.1991; 4 ♂♂, 2 ♀♀, xii.1994; 2 ♂♂, ix.1994; 1 ♂, ix.1988, C. Chaves, M. Espinoza; 2 ♂♂, 1 ♀, ix.1989, C. Moraga & P. Rios; 2 ♂♂, v.1988, M. Espinoza; 14.vii.1993, Gredy, Diego, Carlos; 1 ♂, 1 ♀, same locality 31.iii–29.iv.1992; 1 ♀, 31.iii–29.iv.1992 S. Rojas; viii.1994, J. Acosta, Umaña L. (all in INBio).

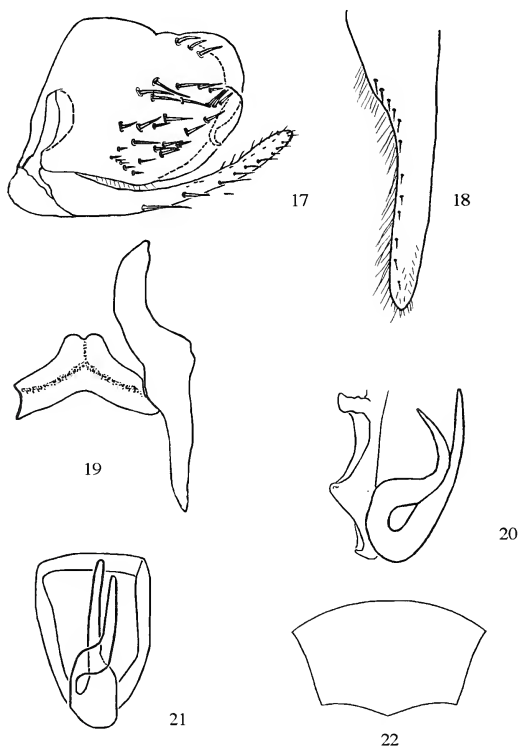
***Nielsonia pucketti*, new species**

(Figs 17–22)

Description. *Length.* Male 7.2–8.5 mm., female 7.0–8.6 mm.

Color. Crown except at apex, apex of pronotum and scutellum, yellow; apex of crown light beige, with a pair of angulate black spots on crown, with an arcuate black line on each side on crown; anterior portion of pronotum beige with a pair of round black spots, posterior two-thirds brown, apex sometimes beige or with a dark pair of subangular black spots on base of scutellum and a black spot before its apex; front black to dark brown; legs yellowish tan to light orange with forewings darker brown. Head and thorax as in *N. serrata*.

Male genitalia. Pygofer with posterior margin convex near apex, with dorsal sclerotized process arising apicodorsally directed posteriorly and attaining apex of pygofer (Fig. 17); plates narrowly triangular, extending posteriorly beyond apex of pygofer, with uniseriate macrosetae (Fig. 18); style extending farther posteriorly than apex of connective, without apical lobe; connective Y-shaped (Fig. 19); aedeagus in lateral view asymmetrical, with shaft strongly curved dorsally, narrowed in its apical half, shaft separated basally from ventral process which arises from ventral portion of atrium (Fig. 20), ventral process in caudoventral view with apex acuminate, extending dorsally parallel to shaft (Fig. 21).



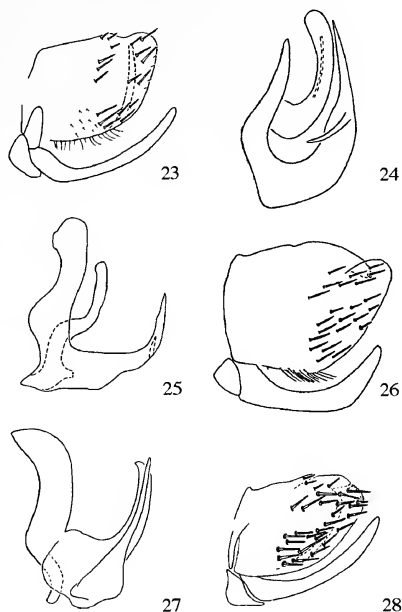
Figs. 17–22. *Nielsonia pucketti*, n. sp.: 17. Pygofer, lateral view; 18. Plate, ventral view; 19. Style dorsal view and connective dorsal view; 20. Aedeagus, lateral view; 21. Aedeagus, caudoventral view; 22. Female abdominal sternum VII.

Female. Abdominal sternum VII with posterior margin tranverse, slightly produced and subangulate medially (Fig. 22).

Discussion. *N. pucketti* resembles *N. praestigia* but *pucketti* has a dorsal sclerotized process on the pygofer. Also, the base of the aedeagal shaft is not closely associated with the base of the aedeagal ventral process. This species is found from 800 to 1500 meters altitude. A few specimens have been collected in coffee plantations.

This species is named in honor of Kirby Puckett of the Minnesota Twins, a player who will never be matched.

Types. Holotype, ♂, COSTA RICA, **Guanacaste**, R. San Lorenzo, 1050 m, R. F. Cord. Guanacaste (Tenorio), C. Alvarado. iv.1991, L-N-287800, 427600 (INBio). Paratypes: COSTA RICA, **Guanacaste**: 24 ♂♂, 10 ♀♀, Estación Pitilla, Fila Orosilito, 9 Km. S. Santa Cecilia, 800–1100 m., 7.iv.1995, M. Moraga, LN 328650–378600. Trampa de luz (25 INBio, 1 CAS, 1 NHM, 1 UCR, 1 USNM, 1 USU); same data except as noted: 3 ♂♂ vi.1989; 2 ♂♂, 3 ♀♀, 3–24.iv.1995, E. Alfaro; 10 ♂♂, A.C. Arenal, Zona Protectora Tenorio, Tierras Morenas, Bajo Los Cartagos, R. San Lorenzo, 1050 m., iv.1991 C. Alvarado, L,N 287800, 427600; same data



Figs. 23–28. Male genitalia (modified from Young, 1977). 23. *Nielsonia pretensa*: Pygofer ventral view. 24. *Nielsonia rostris*: Aedeagus, lateral view. 25. *Nielsonia scissa*: Aedeagus, lateral view; 26. Pygofer lateral view. 27. *Nielsonia praestigia*: Aedeagus, lateral view. 28. *Nielsonia praestigia*: Pygofer lateral view.

except as noted: 1 ♂, iv.1991; 1 ♂ 28.iii-21.iv.1992; 5 ♂♂, 1 ♀, Est. Mengo, SW side Volcan Cacao, 1100 m., ii.1989, GNP, Biodiversity Survey, W 85° 28' 10", N 10° 55' 43"; 1 ♂♂, same data ii.1988, Janzen & Hallwachs; 5 ♂♂, Est. Cacao Lado SO Vol. Cacao, 1000–1400 m., v.1991, Elfin Rainforest 91; 2♂, xi-xii.1989, R. Blanco & C. Chavez; 2 ♂♂, 1400 m., 21–29.iv.1992, III curso parataxonomos. **Puntarenas**: 1 ♀, Res. Biol. Monteverde, Est. La Casona, 1520 m., ii.1993, N. Obando, LN 253250, 449700; same data except as noted: 1 ♂, vi.1991; 1 ♀, ix.1993; 1 ♂ xii.1990, E. Bello; 1 ♂, 3 ♀♀, Est. Biol. Las Alturas, 1500 m., 23.iii.-2.iv.1992, F. Araya, L-S 322500, 591300. **Alajuela**: 1 ♀, R. B. San Ramón, 900 m., 22.ii.–16.iv.1995, G. Carballo, LN 240100, 470100, Malaise; 1 ♂, **Heredia**: San Pedro de Barva, 1200 m. 30.iv.1997, J. González (on coffee); same data except as noted: 1 ♂, 14.iv.1997; 1 ♀, 20.iv.1997; 1 ♀, 15.iii.1997 (all in INBio). **HONDURAS, Cortes**: 1 ♂, San Pedro Sula, Cusuco, 1425 m. 24.ix.1994. rcol R. Cordero (ZEAP). **PANAMA, Potrerillos**: 1 ♂, 4.i.1935. J. M. MacSwain. (USNM)

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The authors thank Humberto Lezama (UCR) and Stuart McKamey (USNM) for loans of specimens and Paul Hanson for comments on the manuscript. Funds were provided by NORAD, and the work was facilitated by the cooperative agreement INBio-MINAE.

LITERATURE CITED

- Young, D. A. 1977. Taxonomic Study of the Cicadellinae. Part 2. New World Cicadellini and the Genus *Cicadella*. North Carolina Agricultural Experiment Station Technical Bulletin 239. 1135 pp.
- Oman, P. W. 1949. The Nearctic Leafhoppers (Homoptera:Cicadellidae). A Generic Classification and Check List. Mem. Entomol. Soc. Wash. 3:1-253.

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**REDESCRIPTION AND PHYLOGENETIC POSITION OF THE
UNUSUAL ALEOCHARINE STAPHYLINID *DIMONOMERA*
INDICA CAMERON, 1933 (COLEOPTERA: STAPHYLINIDAE:
ALEOCHARINAE: DIMONOMERINI)**

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Abstract.—The unusual genus and species *Dimonomera indica* Cameron, currently placed as the sole member of the tribe Dimonomerini, is redescribed, and illustrations of habitus, mouthparts, meso-metasternal areas, tarsi and male genitalia are provided. *Dimonomera* shares numerous characters, some of which are unique among aleocharines, with known members of the tribe Myllaenini. It differs from other myllaenines, especially the type genus *Myllaena*, primarily in the unusual autapomorphic tarsal structure. Tarsal structure is an insufficient criterion for establishing a tribe exclusively to include *Dimonomera*. The results of this study support the proposal that *Dimonomera* should be included in the Myllaenini.

Cameron (1933) described the genus *Dimonomera* and its single species *D. indica* Cameron, and he redescribed the genus and species in 1939 with little change. In both of these works, he noted the remarkable tarsal structure of this beetle. The tarsi of the anterior and middle legs appear to be made up of a single slender, rod-like segment which is as long as the tibia. In contrast, the tarsi of the hind legs are composed of 5, more-or-less uniformly setose segments. This is dramatically different from the tarsal structure of any other known aleocharine staphylinid. This led Cameron (1933) to propose that a new tribe, the Dimonomerini, was needed to contain this species. He mentioned that the species was similar to the genus *Myllaena* (tribe Myllaenini) in habitus, pubescence and “apparently” (Cameron 1939, p. 14) in mouthpart structure (though he did not describe the mouthparts in detail). These statements led Seevers (1978) to propose that the Dimonomerini is closely related to the tribe Myllaenini, and that *Dimonomera* should probably be placed in the Myllaenini. However, as far as I can ascertain *Dimonomera indica* is only known from the type specimen, which has not been examined in detail since it was described by Cameron. Consequently, Cameron’s statements about the similarity of the mouthparts of *Dimonomera* to those of *Myllaena*, and Seevers’ proposed placement of *Dimonomera* in the Myllaenini have not been verified or tested.

I have examined the type, and sole known specimen, of *Dimonomera indica* in the process of on-going studies of the phylogeny of the Myllaenini and related tribes by myself and Kee-Jeong Ahn. My goal in this paper is to redescribe the genus and species in detail, provide adequate illustrations of habitus and diagnostic characteristics and to evaluate Seevers’ proposed placement of *Dimonomera*.

***Dimonomera* Cameron, 1933**

Cameron 1933, p. 103; Cameron 1939, p. 14.

Description. Body form rather flattened, fusiform, broadest at base of pronotum and elytra, abdomen tapered uniformly from broad base to more-or-less pointed apex

(Fig. 1). Head subquadrate (not including postclypeus and labrum), more or less rounded behind, eyes subequal to length of temples behind eyes in dorsal aspect, eyes not bulging or prominent, infraorbital carina complete, rather prominent; neck absent. Antenna very long, with all segments very elongate, apical antennal article without coeloconic sensillae. Labrum (Fig. 2) semicircular, covered uniformly with numerous long setae, apical margin not membranous medially, a-sensory setae short, inflated and hyaline. Adoral surface of labrum (epipharynx) as in Fig. 3. Mandibles (Fig. 4, 5) asymmetrical, right mandible with a small medial tooth, medial tooth absent from left mandible; ventral molar area without patches of denticles; "velvety patch" of dorsal molar region consisting of a transverse apical row of minute denticles and a few irregular rows of smaller denticles basal to the apical row; dorso-lateral margin with numerous setae. Maxillary palpi (Fig. 6) elongate, 4-articled; article 1 short, about $\frac{1}{3}$ as long as article 2; articles 2 and 3 elongate and subequal in length, uniformly covered with numerous microsetae; article 3 spindle-shaped, widest in apical third, and narrowed to base and apex; article 4 very short and minute, about as long as width of apex of article 3. Maxilla (Fig. 6) with galea (Fig. 6b) very elongate and slender, sclerotized to apex, with a few large sensory scales and setae at apex, mesal margin without rows of setae; lacinia (Fig. 6a) elongate and slender, apical third with widely dispersed spinose setae emerging from sockets between spinose scales, middle third with single row of large curved spinose setae; cardo slender and elongate, slightly longer than stipes. Labium as Fig. 7; labial palpi elongate and stylate, appearing 2-articled, articles 1 and 2 indistinguishably fused (limit of primitive article 1 can be determined by presence of "twin pores" that are homologous to those found near the apex of labial article 1 in aleocharine taxa that do not have fused articles), modified and somewhat inflated setae limited to basal half of apparent basal article; ligula of prementum very short, entire, somewhat triangular, with pair of spinose sensory setae; 2 discal setae of prementum with bases close, separated by about width of their punctures; medial pseudopore field narrow, without pseudopores. Mentum (Fig. 8) with anterolateral angles produced as prominent spinose processes. Pronotum strongly transverse, broadest at base, sides rounded, dorsal surface uniformly and broadly convex in cross section, posterior margin slightly bisinuate; hypomera strongly inflexed, not visible in lateral aspect. Elytra longer laterally than at suture; slightly longer than pronotum at suture, postero-lateral angles strongly sinuate. Hind wings present, fully developed. Meso—metasuternum as in Fig. 9, mesosternal process narrow, spiniform, acutely pointed, extended $\frac{2}{3}$ length of mesocoxal cavities, not attaining apex of very short metasternal process (Cameron, 1933, 1939 reports that the mesosternal process extends the entire length of the coxae, but this is incorrect); mesosternal process carinate medially, carina extended from apex of process to near base of mesosternum, but fading before attaining margin of mesosternum, carina especially prominent in apical half of mesosternal process so that apical half of mesosternal process distinctly carinaform; known species with relative lengths of mesosternal process: isthmus: metasternal process 9:3.5:1.5; mesocoxal cavities margined behind; mesocoxae narrowly separated. Middle and hind tibiae with a single large dark seta near middle. Tarsal segmentation appearing to be 1,1,5, with front and hind legs appearing to have a single elongate rod-like segment, subequal in length to tibia; in fact, tarsi of front and middle legs with first 3 basal articles fused into one very short, finely microsetose,

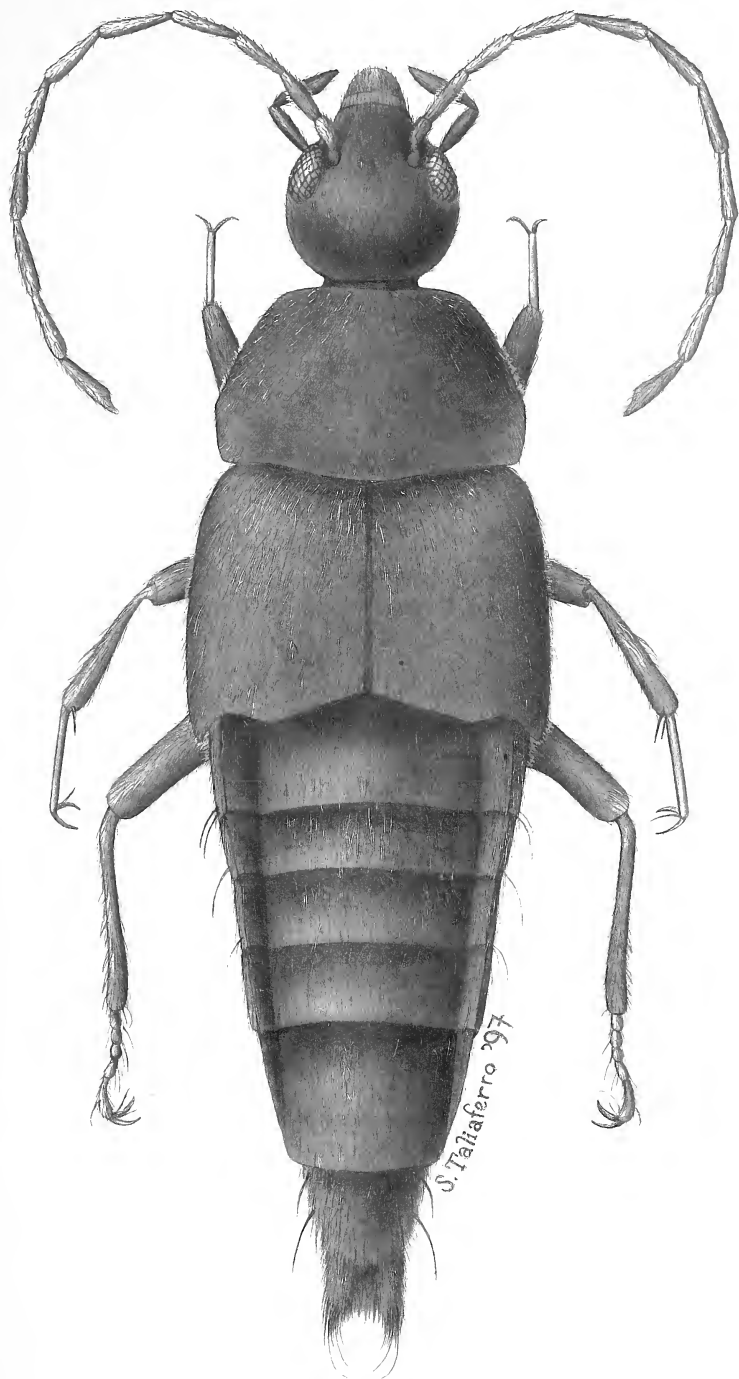
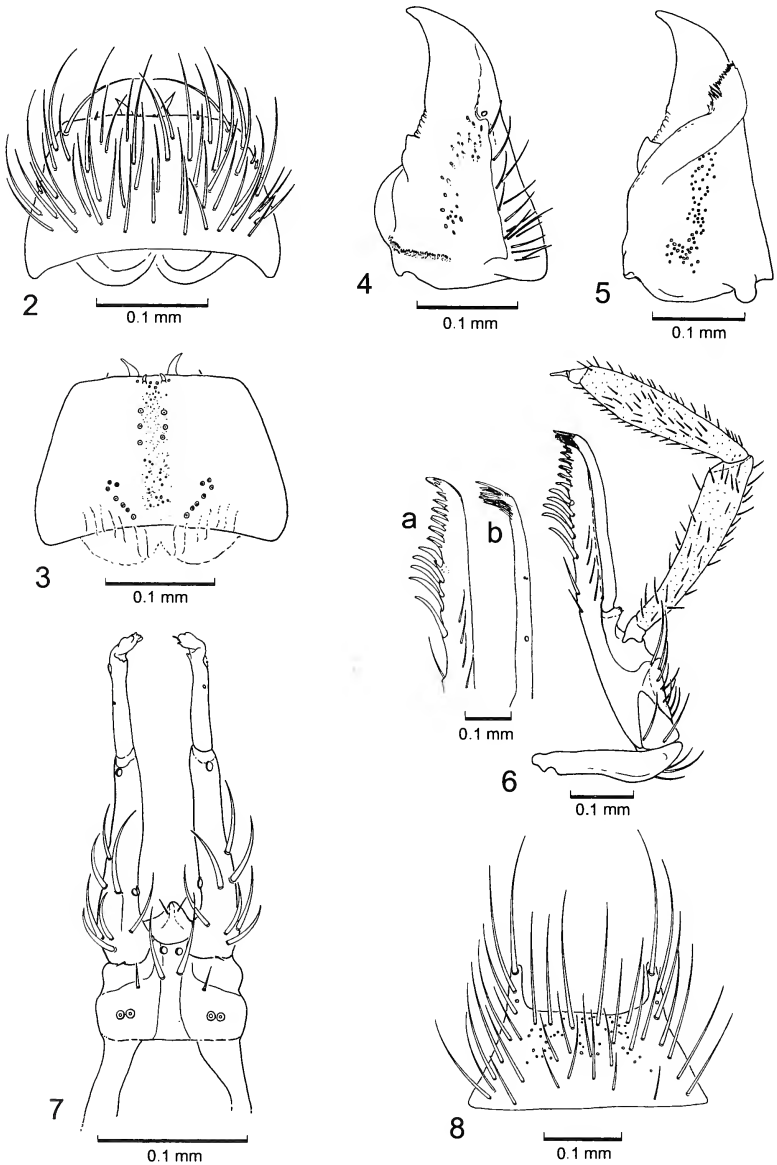
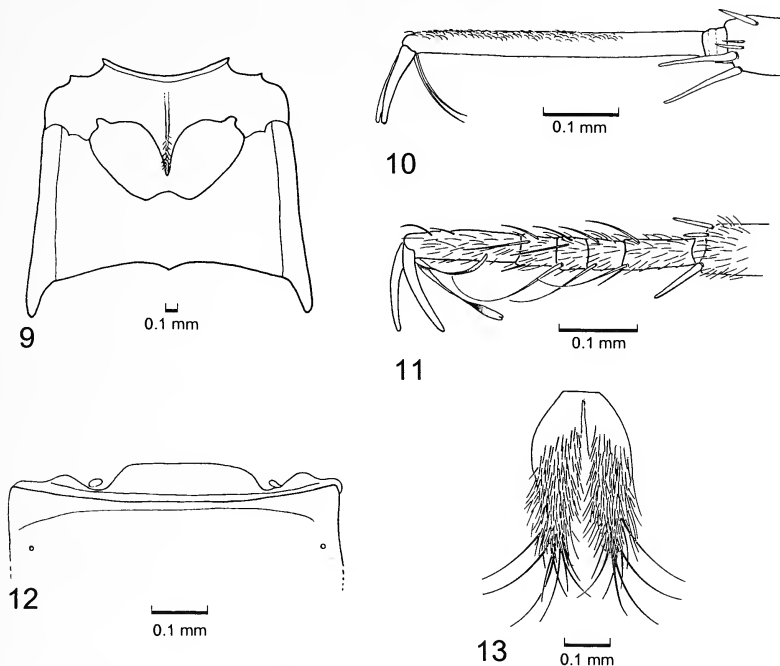


Fig. 1. *Dimonomera indica* Cameron, habitus, length 4.0 mm.



Figs. 2-8. *Dimonomera indica* Cameron. 2. Labrum, dorsal aspect. 3. Labrum, adoral aspect (epipharynx). 4. Right mandible, dorsal aspect. 5. Right mandible, ventral aspect. 6. Maxilla, dorsal aspect, a, lacinia detail, b, galea detail. 7. Labium, ventral aspect. 8. Mentum, ventral aspect.



Figs. 9–13. *Dimonomera indica* Cameron. 9. Meso-metasternum. 10. Middle tarsus. 11. Hind tarsus. 12. Abdominal tergum VII, anterior margin showing opening of tergal gland reservoir. 13. Abdominal tergum X.

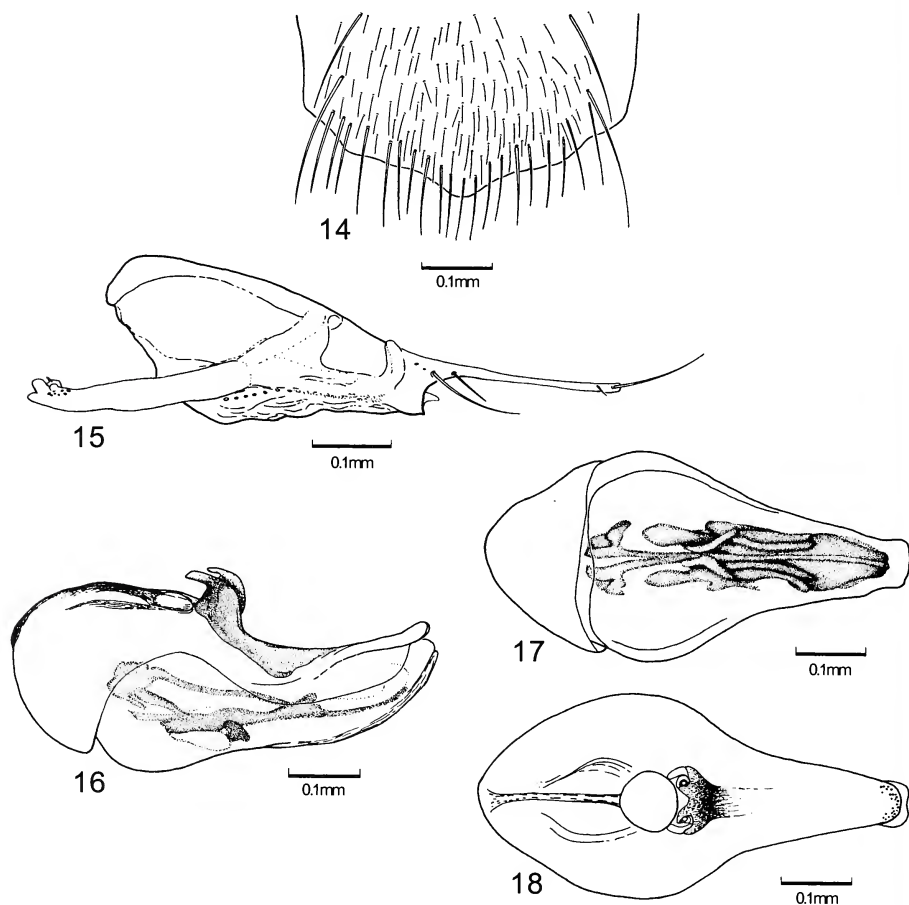
basal article less than 0.08 times length of rod-like article 4 (apparent second article) (Fig. 10). Hind tarsi (Fig. 11) with 5 articles, articles finely microsetose, article 1 slightly longer than 2+3 together, articles 2, 3 and 4 subequal in length, article 5 about as long as 2+3+4 together, longer than article 1. 2 empodial setae present (Cameron, 1933, 1939 incorrectly reports only one “slender appendage” between the claws), elongate, slightly longer than tarsal claws; empodial bristles of front and middle tarsi slender and setiform (Fig. 10), empodial bristles of hind tarsi flattened and subspatulate (Fig. 11). Hind coxae without ventral plate that covers base of femur and trochanter. Abdominal terga without transverse basal impressions. Anterior margin of abdominal tergum VII modified in conjunction with well-developed gland reservoir (Fig. 12). Abdominal tergum X divided by medial lightly sclerotized area into two lateral densely setose regions (Fig. 13).

Type Species. *Dimonomera indica* Cameron, 1933, by monotypy.

Dimonomera indica Cameron, 1933

Cameron 1933, p. 103; Cameron 1939, p. 14.

Description. Length 4.0 mm. Body uniformly dark brown, legs and antennae lighter (the color of the body and appendages of the type specimen is lighter than Cameron describes and may reflect changes resulting from the age of the specimen); closely,



Figs. 14–18. *Dimonomera indica* Cameron. 14. Male abdominal sternum VIII. 15. Paramere of aedeagus, lateral aspect. 16. Median lobe of aedeagus, lateral aspect. 17. Median lobe of aedeagus, ventral aspect. 18. Median lobe of aedeagus, dorsal aspect.

uniformly and finely microsetose with grayish pubescence; integument uniformly and finely reticulate, not shining. Antenna very long, reaching beyond posterior margin of elytra when extended posteriorly, all articles very elongate, each article 3.5–4.0 times longer than greatest width, basal articles very slightly longer than more apical articles, article 11 subequal in length to article 10. Prothorax transverse, about 1.6 times wider than long. Elytra slightly broader than base of pronotum, elytral length at suture about 1.1 times longer than pronotum at midline, lateral margins about 1.4 times longer than pronotum at midline; postero-lateral margins strongly sinuate.

Secondary Sexual Characteristics. Dorsal abdomen without apparent secondary sexual characteristics; posterior margin of male abdominal sternum VIII produced medially into very short and broad V-shaped lobe (Fig. 14).

Aedeagus. Parameres (Fig. 15) with very long, slender apical process with 4 setae, apical and basal setae large, subbasal seta medium sized and subapical seta minute. Median lobe (Figs. 16, 17, 18) with complex internal sclerites, and very large, paired, heavily sclerotized, hook-shaped processes for attachment of condylites of parameres.

Type. Holotype. ♂, with labels as follows: a small red, round "type" label; "Shugnu, 3000", Assam (14)", "*Dimonomera indica* Cam., TYPE", "M. Cameron, Bequest, BM 1955-147". In the collection of the Natural History Museum, London. Specimen is dissected; right middle and right hind leg and mouthparts are stored in glycerin in a genitalia vial pinned beneath the specimen; abdominal segments VII-X and the dissected aedeagus are in glycerin in a second genitalia vial pinned beneath the specimen. The remaining body parts including head, antennae and legs are glued onto the original specimen card.

Other specimens. No other specimens are known. Cameron (1933, 1939) seems to imply that there are other specimens available, reporting specimens from "Shugnu, alt. 3000 ft." and "Sarju Valley, alt. 5000 ft.". However, I only received the type specimen from the Natural History Museum, and Mr. Brendell noted (in litt.) that he sent all the specimens available.

Distribution. Known only from 3,000 feet elevation in the state of Assam in north-western India (but see notes about other specimens above).

PHYLOGENETIC RELATIONSHIPS

Structural features of *Dimonomera* were compared with known members of the tribe Myllaenini, especially with *Myllaena*, the type genus of the tribe. *Dimonomera* shares the following characters with members of the Myllaenini:

1. Labrum semicircular with numerous, uniformly distributed setae and similar sensory elements medially (Fig. 2).
2. Lacinia elongate, stylate, with widely dispersed teeth and spines in apical third, each spine emerging from a socket between spinose scales (Fig. 6a).
3. Galea elongate, very slender, sclerotized to apex, with enlarged sensory scales and setae only at apex, without setae on mesal margins (Fig. 6b).
4. Cardo elongate, about as long as stipes (or longer in *Dimonomera indica*) (Fig. 6).
5. Maxillary palpus 4-articled, very long, article 3 spindle-shaped; article 4 very small, no longer than width of article 3 at apex (Fig. 6).
6. Labial palpi elongate and stylate, articles 1 and 2 fused, setae limited to basal half of apparent article 1 (Fig. 7). (Note that Klimaszewski 1982 interpreted the labial palpi of myllaenines to be absent, and the "glossae" to be styliiform; however this interpretation is incorrect. The setae, sensory pores, relative position and remaining sutures on the labial palpi of *Myllaena* can be directly homologized with those of other aleocharine staphylinids.)
7. Ligula of prementum short, entire (very short and sub-triangular for *Dimonomera*), with a pair of medial sensory setae (Fig. 7).
8. 2 discal setae of prementum, bases close.
9. Medial pseudopore field without pseudopores (Fig. 7).
10. Mentum with apico-lateral margins produced into spinose processes (Fig. 8).

11. Two empodial setae, at least some modified—flattened and subspatulate (Fig. 10, 11).
12. Setose areas of abdominal tergum X divided into 2 setose lobes by a medial unsclerotized region (Fig. 13).
13. Apical process of paramerite of paramere very elongate and slender with 4 setae (4 setae is the primitive condition in the Aleocharinae) (Fig. 15).

Of these similarities, the detailed structure of the galea and lacinia of the maxilla, detailed structure of the labial palpi, spinose processes on the apico-lateral margins of the mentum, and presence of 2 flattened and subspatulate empodial setae (at least on the hind tarsi), are features that are unique to the Myllaenini as far as is known (somewhat similar features occur individually in a few other aleocharines, but the detailed structure differs, suggesting that they are not homologous with those of the Myllaenini). These features are probably synapomorphies for members of this tribe. The other characteristics mentioned are, in combination, very distinctive for the Myllaenini, but they occur in various combinations in other groups of aleocharines, and their status as possible synapomorphies for the Myllaenini cannot be properly evaluated except in the context of a more comprehensive phylogenetic study (currently in progress by the author and Dr. Kee-Jeong Ahn).

In addition, the unique tarsal structure of *Dimonomera* appears to be a modification of the 4-4-5 segmentation typical of members of the Myllaenini. The very short basal segment on the front and middle tarsi appears to be made up of 3 very shortened and fused articles—the divisions between the articles are faintly visible when examined at high magnification with Differential Interference compound optics. Other features shared (not uniquely) between *Dimonomera* and the genus *Myllaena* include the fusiform body form with very similar pubescence and microsculpture and the emarginate apex of abdominal tergum 10 so that tergum 10 is bilobed (see Klimaszewski 1982).

Though the limits of the Myllaenini are still uncertain and are currently under investigation by the author and his colleagues, it seems clear *Dimonomera* is an aberrant myllaenine. It shares numerous uniquely derived characters with known members of the Myllaenini. Indeed, *Dimonomera* differs from other myllaenines (especially the type genus *Myllaena*) primarily in the unusual tarsal structure. This feature is strictly an autapomorphy, and is an insufficient criterion for establishing a tribe exclusively to include *Dimonomera*. The results of this study support Seevers' (1978) proposal that *Dimonomera* should be included in the Myllaenini.

ACKNOWLEDGEMENTS

I thank M. J. D. Brendell, and The Natural History Museum, London, for loan of the type of *Dimonomera indica* and for permission to dissect this very valuable specimen. Study of the phylogenetic position of this remarkable beetle would have been impossible without careful dissection and detailed study of the mouthparts and genitalia. The wonderful habitus and structural illustrations are the work of Ms. Sara Taliaferro. This research was made possible by National Science Foundation PEET Grant DEB 95-21755 to James S. Ashe.

LITERATURE CITED

- Cameron, M. 1933. Description of a new genus of Staphylinidae from India. *Entomologist's Monthly Magazine*, 69:103.

- Cameron, M. 1939. Coleoptera, Staphylinidae. Vol. IV. Parts I&II. In: Sewell, R. B. S., ed., Fauna of British India, including Ceylon and Burma. Taylor & Francis, London. XVIII + 691 pp., plates 1-3.
- Klimaszewski, J. 1982. A redefinition of Myllaenini Ganglbauer and redescription of *Camacopalus* Motschulsky and *Polypea* Fauvel (Coleoptera: Staphylinidae). Canadian Entomologist 114:411-429.
- Seevers, C. H. 1978. A generic and tribal revision of the North American Aleocharinae (Coleoptera: Staphylinidae). Fieldiana: Zoology, 71:vi + 275 pp.

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STUDIES ON THE GENUS *APHODIUS* OF THE UNITED STATES AND CANADA (COLEOPTERA: SCARABAEIDAE). IX. A NEW SPECIES FROM KANSAS AND TEXAS

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Abstract.—*Aphodius kiowensis*, n. sp., from Kansas and the Texas panhandle, is described and illustrated. Its biology and habitat are discussed, as are the species of rodents having *Aphodius* associates in collecting areas in southern Kansas. The pertinent Kansas habitats and possible biological scenarios are discussed.

Recent collections in rodent burrow communities in Kansas resulted in the discovery of an undescribed species of *Aphodius* previously known from a single Texas specimen. This species is described to make the name available for research conducted prior to a revisionary study on North American *Aphodius*.

The biology of *A. kiowensis*, n. sp., is unknown. It may be a detritivore or a rodent burrow associate because all specimens examined, with the exception of the Texas paratype, were collected in flight over areas populated by rodents or actually in rodent burrows. The primary method employed was to wait for a calm, sunny day with temperatures above 50°F and begin collecting approximately one to two hours before sunset. At that time, while facing the sun, the beetles were easily seen flying just above the grass and collected with a sweep net. The greatest variety of species and largest number of beetles were collected during the months of October, November, and December. Beetles were collected at most times of the day but late afternoon proved to be the most productive period. Some collecting was also done at openings of prairie dog burrows where one paratype of *A. kiowensis* was found, and in kangaroo rat burrows where two specimens were collected.

The terrain in all of the Kansas counties where *A. kiowensis* was collected consists of rolling sand hills in either the Arkansas River lowlands or high plains physiographic regions. These regions have a fine, sandy loam soil type and are utilized as livestock pasture, most of which is overgrazed. Prominent native grasses are buffalograss, *Buchloe dactyloides* (Nutt.), and blue grama, *Bouteloua gracilis* (H.B.K.) Lag. Field sandbur, *Cenchrus pauciflorus* Benth., is one of the dominant grasses in one Kiowa County pasture. Principle rodents are the blacktailed prairie dog, (*Cynomys ludovicianus ludovicianus* (Ord)); plains pocket gopher, *Geomys bursarius* (Shaw); and Ord's kangaroo rat, *Dipodomys ordii richardsoni* (J. A. Allen). At the collection site in Seward County, and at one site in Kiowa County, both pocket gophers and prairie dogs were present. At one site in Kiowa County both pocket

gophers and kangaroo rats were abundant. At the collecting sites in Comanche County, gophers were the primary rodent species.

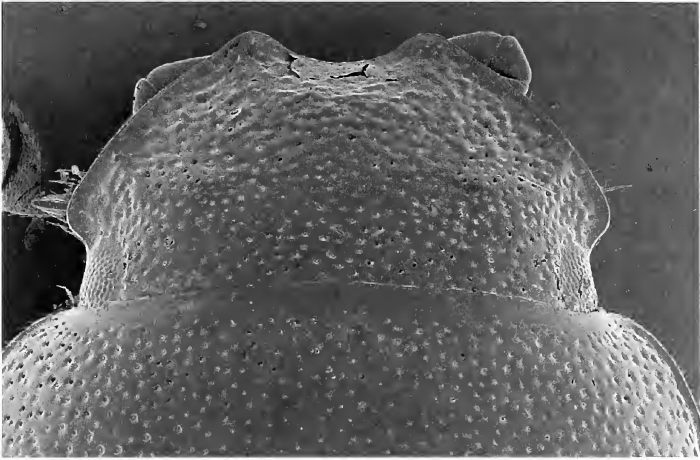
Other species of *Aphodius* primarily associated with pocket gophers that were collected at the Kansas sites were *A. magnificens* Robinson, *A. concavus* Say, *A. insolitus* Brown, *A. acuminatus* Cartwright, *A. haldemani* Horn, and *A. sepultus* Cartwright.

Type depository acronyms are: (FSCA) Florida State Collection of Arthropods, Gainesville, Florida; (GAS) Glenn A. Salsbury, Greensburg, Kansas; and (USNM) United States National Museum of Natural History, Washington, DC.

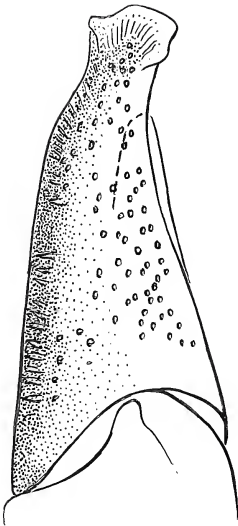
Aphodius kiowensis, new species

Description. *Male.* Length 5.0 mm, width 2.6 mm. Body elongate, slender, widest posterior to middle of elytra. Color mostly yellowish brown except head and pronotum slightly darker reddish brown; ventral surface dark brown. Head except vertex densely rugose; clypeus with apex deeply emarginate medially, with large, broad, blunt tooth on each anterior angle (Fig. 1); clypeal suture slightly transversely raised; gena distinct, fimbriate; frontal suture barely visible, tubercles faintly indicated; vertex densely, coarsely punctured, punctures mostly contiguous. Pronotum wide, slightly explanate with faint concavity at hind angle; basal margin with complete border; pronotal surface feebly shiny, slightly alutaceous, with punctation of 2 sizes, punctures separated by approximately a diameter on disc, becoming denser toward lateral margin, contiguous or nearly so near anterior and posterior angles. Elytron shiny, surface with fine, short, sparse, nearly invisible setae; striae distinctly impressed, stria punctures fine; intervals flat with row of dense, fine punctures on each side near striae. Mesosternum shiny, flat between coxae. Metasternum shiny, slightly concave medially, with scattered coarse punctures laterally and relatively dense, coarse punctures medially. Protibia with apical spur large, long, strongly curved ventrally in apical $\frac{1}{2}$, length equal to basal 3 tarsal segments. Meso- and metatrochanter with patch of long setae in apical $\frac{1}{2}$, each patch with single very long seta in middle. Meso- and metafemur with long setae along lateral margin, setae forming patch near trochanter. Mesotibia with apical setal fringe composed of alternate long and short setae except with two intervening short setae medially, long setae distinctly longer than inferior mesotibial spur; inferior spur $\frac{1}{3}$ length of superior spur, slender, slightly bent inward before apex, apex with small, abrupt angle/spine in lateral view. Metatibia with apical fringe same as for mesotibia except long setae slightly shorter than inferior spur; inferior metatibial spur $\frac{1}{2}$ length of basal tarsal segment, superior spur $\frac{3}{4}$ length of basal tarsal segment. Metatarsus slightly longer than metatibia, tarsal segments slender, basal segment as long as segments 2–3 combined. Epipharynx transverse, side rounded, apical margin nearly truncate; epitorma rectangular; corypha not protruding, located below apical margin, with apical clump of elongate, slender spinules; pedia nearly glabrous, with complete row of chaetae; chaetopariae moderately dense, short. Genitalia unmodified, paramere slightly curved apically, without apical membranous appendage (Figs. 2, 3).

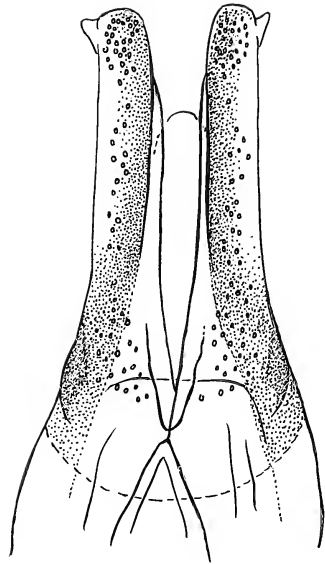
Female. Similar to male except pronotum slightly narrower; pro- and mesotibial spurs unmodified; meso- and metatrochanter without patch of long setae; meso- and metafemora without patch of long setae near trochanter.



1



2



3

Figs. 1-3. *Aphodius kiowensis*, n. sp. Fig. 1, head, dorsal view; Fig. 2, male genitalia, lateral view; Fig. 3, male genitalia, ventral view.

Variation. Length 4.5 to 5.2 mm, width 2.2 to 2.8 mm; elytra light yellow to dark yellowish brown.

Types. Holotype, ♂, UNITED STATES, **Kansas**, Comanche Co., 4 mi NW Coldwater, 8.xii.1996, G. Salsbury, in flight (USNM). Allotype, UNITED STATES, **Kansas**, Kiowa Co., 5 mi N Greensburg, 22.xi.1997. G.A. Salsbury, in flight (USNM). Paratypes: 13; UNITED STATES, **Kansas**: 3, same data as allotype; 1, Kiowa Co., 5 mi N Greensburg, 14.xii.1996, G. Salsbury, kangaroo rat burrow dung trap; 1, Kiowa Co., 10 mi NW Mullinville, 13.xi.1996, G. Salsbury, kangaroo rat burrow dung trap; 1, Kiowa Co., 10 mi NW Mullinville, 27.iv.1997, G. Salsbury, prairie dog burrow; 3, Kiowa Co., 10 mi NW Mullinville, 4-xi-1996, 2-xi-1996, G. Salsbury, ex: in flight; 3, Seward Co., 14 mi N Liberal, 24.xi.1997, G.A. Salsbury, in flight. **Texas**: 1, Hansford Co., Coldwater Crk. & TX 15, B-103, III-18-82, Human dung. (FSCA)(GAS)(USNM).

Remarks. *Aphodius kiowensis* resembles *A. anomaliceps* Brown and is likely to be confused with that species. *Aphodius anomaliceps* differs from *A. kiowensis* by having lateral margin of head posterior to anterior clypeal angle irregular, slightly sinuate; apical margin of clypeus thickened between teeth; pronotum narrow, convex, not at all explanate and without trace of posterolateral concavity; and intervals of elytron feebly punctured. The group of species containing *A. anomaliceps* is partially characterized by having a long epipharyngeal corypha, extended well beyond the epipharyngeal apex, and apex of the corypha with 2 short, stout, apical spinules. *Aphodius kiowensis* has the corypha located below the apical epipharyngeal margin and the coryphal apex has an apical clump of elongate, slender spinules.

The specific habitat of *A. kiowensis* is unknown, as previously discussed. Based on experience with other species of *Aphodius*, only two scenarios are likely - *A. kiowensis* is either a detritivore, or an obligate resident of rodent burrows.

Etymology. This species is named for one of the Kansas counties in which most of the specimens were collected.

ACKNOWLEDGMENTS

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**REDESCRIPTION AND NOTES ON THE BIOLOGY OF
AMECOCERUS SENILIS (LECONTE) (COLEOPTERA:
MELYRIDAE: DASYTINAE)**

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Abstract.—A redescription of *Amecocerus senilis* (LeConte) (Coleoptera: Melyridae: Dasytinae) is provided based on the author's examination of 875 specimens of this species. The male genitalia of *A. senilis* are illustrated and compared with those of *A. suckeri* Hatch, a related species from Washington and Oregon. Adults of *A. senilis* occur abundantly on flowers in open forests of *Pinus ponderosa* Douglas in the vicinity of Estes Park, Colorado. Flowers on which adults of *A. senilis* were collected during this study include *Achillea lanulosa* Nuttall, *Cerastium arvense* L., *Erigeron annuus* (L.) Persoon, *Eriogonum heracleoides* Nuttall, *Gaillardia aristata* Pursh, *Geranium viscosissimum* Fischer and Meyer, *Grindelia squarrosa* (Pursh) Dunal, *Potentilla gracilis* Douglas, and *Solidago occidentalis* (Nuttall) Torrey and Gray.

INTRODUCTION

The subfamily Dasytinae of the beetle family Melyridae must certainly rank among the most poorly-known groups of Coleoptera in North America. At the present time, the most recent works treating most of the genera and species of Nearctic Dasytinae are the monograph of the subfamily by Casey (1895) and a series of shorter papers by Casey's protégé Blaisdell (summarized by Arnett, 1968). Casey is well-known as a taxonomic "splitter" (see discussion in Hatch, 1926) and it seems probable that many of the numerous species and genera described by Casey in Dasytinae will be placed in synonymy when the Nearctic Dasytinae are comprehensively revised by workers with access to large series of specimens from many localities.

Recent studies of species of Dasytinae from North America are few in number and nothing has been published on the biology of most of the species in this group. The following notes on *Amecocerus senilis* (LeConte) were prepared following two collecting trips to Estes Park, Colorado, during July, 1996, and August, 1998.

***Amecocerus senilis* (LeConte, 1852)**

Figs. 1–2

Dasytes senilis LeConte, 1852:170 [Holotype, male, labeled with pale green disc (=Nebraska, Kansas, North Dakota, South Dakota, Oklahoma, Wyoming, Montana), MCZ Type No. 3518, examined; type locality given in original description as Fort Laramie, Nebraska Territory].

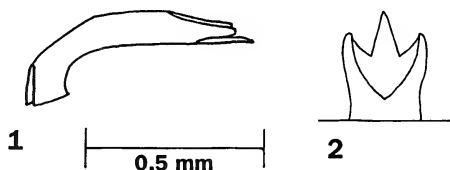
Listrus senilis: LeConte, 1866:358; Casey, 1895:542, 551; 1897:682; Champion, 1914:114, 118 (in part); Blaisdell, 1921:175–176.

Amecocerus senilis: Pic, 1937:102.

Diagnosis. *Amecocerus senilis* appears to be closely allied to *A. suckeri* Hatch, a species with similar uniform greyish-white dorsal vestiture described from eastern Washington and eastern Oregon. The femora and tibiae are reddish in *A. suckeri* and black in *A. senilis*. In lateral view, the lateral lobes of the male genitalia of *A. suckeri* are broader than those of *A. senilis* and are more strongly divergent from the median lobe. According to Blaisdell (1921:176), three species described from Arizona and Colorado, *A. clavicornis* (Casey), *A. uniformis* (Casey), and *A. coloradensis* (Blaisdell), are also similar to *A. senilis* in having a uniformly white or greyish-white dorsal vestiture. However, these three species have dorsal setae which are much sparser and finer than those of *A. senilis* (Blaisdell, 1921:176).

Description. *Length.* 2.68 mm to 3.20 mm. *Body.* Elongate, slender, subcylindrical; female distinctly broader than male. *Integument.* Black, shining, frequently with metallic blue or coppery sheen. *Setae.* Uniform dorsally, white to greyish-white, suberect and moderately dense; white setae slightly denser ventrally; tarsi and sixth visible abdominal sternite with dense, black setae. *Head.* As broad as pronotal apex. *Eyes.* Small, black, lateral, finely granulate, feebly emarginate anteriorly. *Frons.* Densely, rugosely punctate, with a small glabrous median tubercle along anterior margin. *Mouthparts.* Clypeus and labrum small, brown, elongate; mandibles recurved, not visible from above in repose; labrum and maxillae of normal size, terminal palpomeres subulate. *Antennae.* Extending nearly to base of pronotum; antennomere 1 globose, greatly enlarged, antennomere 2 globose, small; antennomeres 3–8 moderately and somewhat increasingly strongly serrate; antennomeres 9–11 expanded laterally, forming a very loose club which is more strongly transverse in male. *Pronotum.* Convex, slightly broader than long, broadest at basal third and tapering to base and apices; disc coarsely, densely punctate, punctures often becoming strongly rugose; lateral margin minutely serrate; anterior, posterior, and lateral margins outlined by a row of reclinate overlapping white setae. *Scutellum.* Transverse, small, covered in dense white pubescence. *Elytra.* Elongate, subcylindrical; slightly broader than pronotum at base; strongly convex, with a distinct transverse impression at basal third; elytral humeri strongly angulate; lateral margins broadening gradually to apical third, then broadly tapering to separately rounded apices; lateral margins of elytra outlined by a row of reclinate overlapping white setae; elytra coarsely, densely, and irregularly punctate basally, punctures becoming much smaller towards apices. *Venter.* Minutely, densely punctate. *Fifth visible abdominal sternite.* Elongate and apically emarginate in males, shorter and rounded apically in females. *Legs.* Short, femora somewhat clavate, metafemora strongly clavate in male; tibiae longer than femora, slightly compressed in cross-section, slightly broader towards apices, with a pair of reddish-brown tibial spurs and dorsal black spines at apices; pretarsal claws with pale ventral appendages extending the length of the claws. *Male genitalia.* Similar to those of *A. suckeri* Hatch (1961:402–403); lateral lobes slender, divergent, broadly rounded apically; sclerotized portion of median lobe elongate, triangular, slightly depressed towards apex and extending beyond apices of lateral lobes; median and lateral lobes not strongly divergent in lateral view (Figs. 1–2).

Material Examined. UNITED STATES, **Arizona:** 11 adults, Grand Canyon, 18.viii.1929 (CUIC); 18 adults, Hermit Rim Road, Grand Canyon, 1.viii.1914, J. C. Bradley (CUIC); 2 adults, no locality specified (CUIC). **Colorado:** 1 adult, Alamosa Co., Great Sand Dunes National Monument, 28.vii.1988 (CUIC); 13 adults, Larimer



Figs. 1–2. *Amecocerus senilis* (LeConte), male genitalia, lateral view (Fig. 1) and dorsal view of apex (Fig. 2).

Co., Roosevelt National Forest, Comanche Peak Wilderness, along North Fork of Big Thompson River, 20.vii.1996, J. R. Mawdsley (JRMA); 25 adults, Larimer Co., Estes Park, 22.vii.1996, J. R. Mawdsley (JRMA); 93 adults, Larimer Co., Estes Park, 24.vii.1996, J. R. Mawdsley (JRMA); 660 adults, Larimer Co., Estes Park, 5.viii.1998, J. R. Mawdsley (AMNH, CUIC, JRMA, MCZC, and USNM); 4 adults, Colorado Springs, 7.vii.1927 (CUIC); 4 adults, Golden, 23.vi.1911 (CUIC); 18 adults, no locality specified (CUIC). **Nebraska:** 1 ♂, Fort Laramie (MCZC). **New Mexico:** 2 adults, Bent, 1–15.viii.1927 (CUIC); 2 adults, near Hot Springs, Las Vegas, 7,000 feet, viii.1882, F. H. Snow (CUIC); 16 adults, Mescalera Reservation, 15.viii.1927 (CUIC); 1 adult, Mescalera Reservation, 10.ix.1927 (CUIC). **Utah:** 1 adult, Bryce Canyon, 20.viii.1929 (CUIC); 3 adults, Bryce Canyon, 21.viii.1929 (CUIC).

Notes on synonymies. Champion (1914) placed as synonyms of this species two taxa proposed in the genus *Listrus*: *Listrus canescens* Motschulsky, described from California, and *Listrus clavicornis* Casey, described from Arizona. However, Champion does not state in his revision that he had examined the types of these species, and since his treatment of *A. senilis* and its supposed synonyms is based entirely on specimens from Mexico and Central America, it is evident that these names should be excluded from synonymy until the types can be examined. It is probable that Champion's synonymy of *L. canescens* refers rather to the treatment of this species by H. S. Gorham (1882; 1886) in the *Biologia Centrali-Americana* than to the species from California described by Motschulsky. A revision of these names which incorporates examination of the type specimens of *L. canescens* and *L. clavicornis* as well as those specimens on which Gorham's treatment of *L. canescens* was based is clearly desirable, but such a revision falls outside the scope of the present paper.

Notes on relationships. Blaisdell (1921:176) included this species in his "*senilis* group," which was diagnosed on the basis of unicolorous pale elytral pubescence (most other species of *Amecocerus* have white, black, or brown pubescence arranged in bands, spots, or other patterns). The three other species included in this group by Blaisdell seem doubtfully distinct from *A. senilis* and may be synonyms of it. Hatch (1961:75–76; 402–403) described and illustrated the male genitalia of *A. suckeri* Hatch, the only species of *Amecocerus* with unicolored pale pubescence known from the Pacific Northwest. Hatch's work was the first to use characters of the male genitalia in separating species of *Amecocerus*. However, Hatch made no attempt to establish a complete synonymy for the species he studied, instead describing most of the forms he examined as new species and leaving the question of their validity for future workers. *Amecocerus suckeri* appears to be a valid species, distinguishable

from *A. senilis* on the basis of its reddish femora and tibiae and its different male genital morphology (in lateral view, the lateral lobes are broader than those of *A. senilis* and are more strongly divergent from the median lobe).

NOTES ON BIOLOGY

Amecocerus senilis (LeConte) is abundant in the Village of Estes Park and at lower elevations in canyons of the surrounding Roosevelt National Forest and Rocky Mountain National Park, Larimer Co., Colorado. It appears to be confined to open forests of *Pinus ponderosa* Douglas and is replaced at higher elevations (above 9,500 feet) by the larger, black species *Dasytes hudsonicus* LeConte.

On July 22 and 24, 1996, I collected 118 adults of *A. senilis* on flowers of *Achillea lanulosa* Nuttall, *Gaillardia aristata* Pursh, and *Geranium viscosissimum* Fischer and Meyer in a one-acre field belonging to Katharine S. and Charles A. Johnson at an approximate elevation of 8,000 feet in the Village of Estes Park. On August 5, 1998, I returned to this same field and collected all adult specimens of *A. senilis* from all species of plants in flower. A total of 660 adults were collected on flowers of the following species: *Achillea lanulosa* Nuttall (290 adults); *Cerastium arvense* L. (26 adults); *Erigeron annuus* (L.) Persoon (13 adults); *Eriogonum heracleioides* Nuttall (55 adults); *Gaillardia aristata* Pursh (48 adults); *Geranium viscosissimum* Fischer and Meyer (43 adults); *Grindelia squarrosa* (Pursh) Dunal (146 adults); *Potentilla gracilis* Douglas (1 adult); *Solidago occidentalis* (Nuttall) Torrey and Gray (38 adults). Based on observations of adults in the field and examination of stomach contents, adult *A. senilis* consumed both nectar and pollen from these flowers. Species of plants in flower in this field on August 5, 1998, which lacked adults of *A. senilis* included *Campanula rotundifolia* L. and *Verbascum thapsus* L.

ACKNOWLEDGMENTS

I would like to thank Katharine S. and Charles A. Johnson for permission to collect specimens of *Amecocerus senilis* on their property. James K. Liebherr and E. Richard Hoebeke allowed me to examine specimens of *Amecocerus senilis* in the Cornell University Insect Collection (CUIC). David G. Furth and Philip D. Perkins of the Museum of Comparative Zoology, Harvard University (MCZC), allowed me to examine the holotype of *Amecocerus senilis* (LeConte). Additional collections in which specimens are deposited include the American Museum of Natural History (AMNH), the author's personal collection (JRMA), and the National Museum of Natural History, Smithsonian Institution (USNM). Funding for this study was provided by a National Science Foundation Graduate Research Fellowship and a Graduate Fellowship from the Spencer T. and Ann W. Olin Foundation.

LITERATURE CITED

- Arnett, R. H. 1968. The Beetles of the United States (a manual for identification). Ann Arbor: American Entomological Institute. xii + 1112 pp.
- Blaisdell, F. E. 1921. New species of Melyridae, Chrysomelidae, and Tenebrionidae (Coleoptera) from the Pacific coast, with notes on other species. Stanford University Publications, Biological Sciences 1(3):136-231.
- Casey, T. L. 1895. Coleopterological Notices VI. Annals of the New York Academy of Sciences 8:435-838.

- Casey, T. L. 1897. Coleopterological Notices VII. *Annals of the New York Academy of Sciences* 9:285–684.
- Champion, G. C. 1914. Revision of the Mexican and Central-American Malachiidae and Melyridae, with descriptions of new species. *Transactions of the Entomological Society of London* 1914:13–127.
- Gorham, H. S. 1882. Melyridae, Cleridae. *Biologia Centrali-Americana, Insecta Coleoptera* 3(2):113–168.
- Gorham, H. S. 1886. Supplement to Malacodermata. *Biologia Centrali-Americana, Insecta Coleoptera* 3(2):313–360.
- Hatch, M. H. 1926. Thomas Lincoln Casey as a Coleopterist. *Entomological News* 37:175–179 + 198–202.
- Hatch, M. H. 1961. *The Beetles of the Pacific Northwest*, Vol. 3. Seattle: University of Washington Press. 503 pp.
- LeConte, J. L. 1852. Catalogue of the Melyrides of the United States, with descriptions of new species. *Proceedings of the Academy of Natural Sciences of Philadelphia* 6:163–171.
- LeConte, J. L. 1866. Revision of the Dasytini of the United States. *Proceedings of the Academy of Natural Sciences of Philadelphia* 19:349–361.
- Pic, M. 1937. Dasytidae: Dasytinae. *Coleopterorum Catalogus* 155:1–130.

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DESCRIPTION OF A NEW SPECIES OF *CRINITELLA* (EPHEMEROPTERA: EPHEMERELLIDAE) FROM THAILAND

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Abstract.—A new species of Ephemerellidae, *Crinitella permkami* sp. nov., is described from southern Thailand. Illustrations of the dorsal habitus and mouthpart structure are provided. This is the first species of *Crinitella* and only the fifth species of Ephemerellidae reported from Thailand.

บทคัดย่อ —*Crinitella permkami* sp. nov. เป็นแมลงชีปะขาวชนิดใหม่ในสกุล Ephemerellidae ได้ถูกรายงานจากภาคใต้ของประเทศไทย ในพื้นที่นี้ได้นำเสนอรูปวิธานลักษณะด้านบน และส่วนประกอบของปาก แมลงชีปะขาวชนิดนี้เป็นชนิดแรกของ *Crinitella* และหนึ่งในห้าชนิดของแมลงชีปะขาวในสกุล Ephemerellidae ที่ได้ถูกรายงานจากประเทศไทย

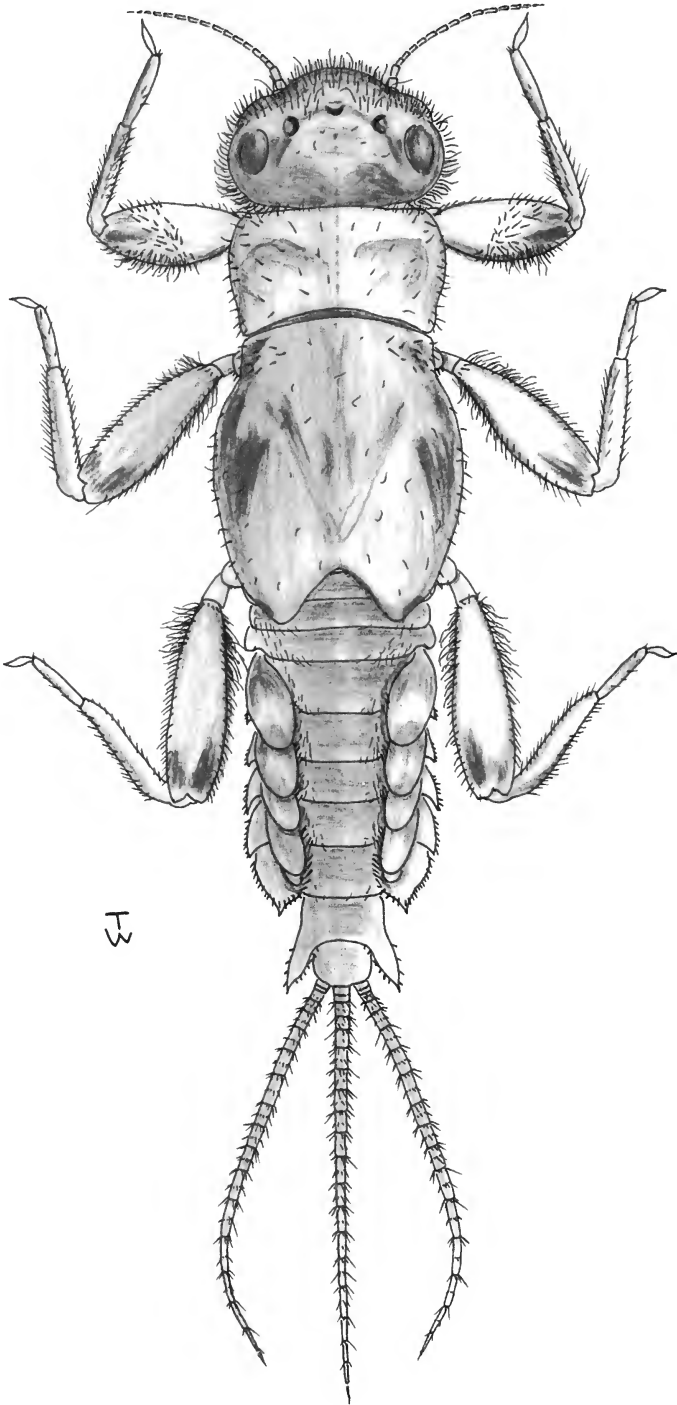
Key Words. Thailand, Ephemeroptera, Ephemerellidae, *Crinitella permkami*, new species.

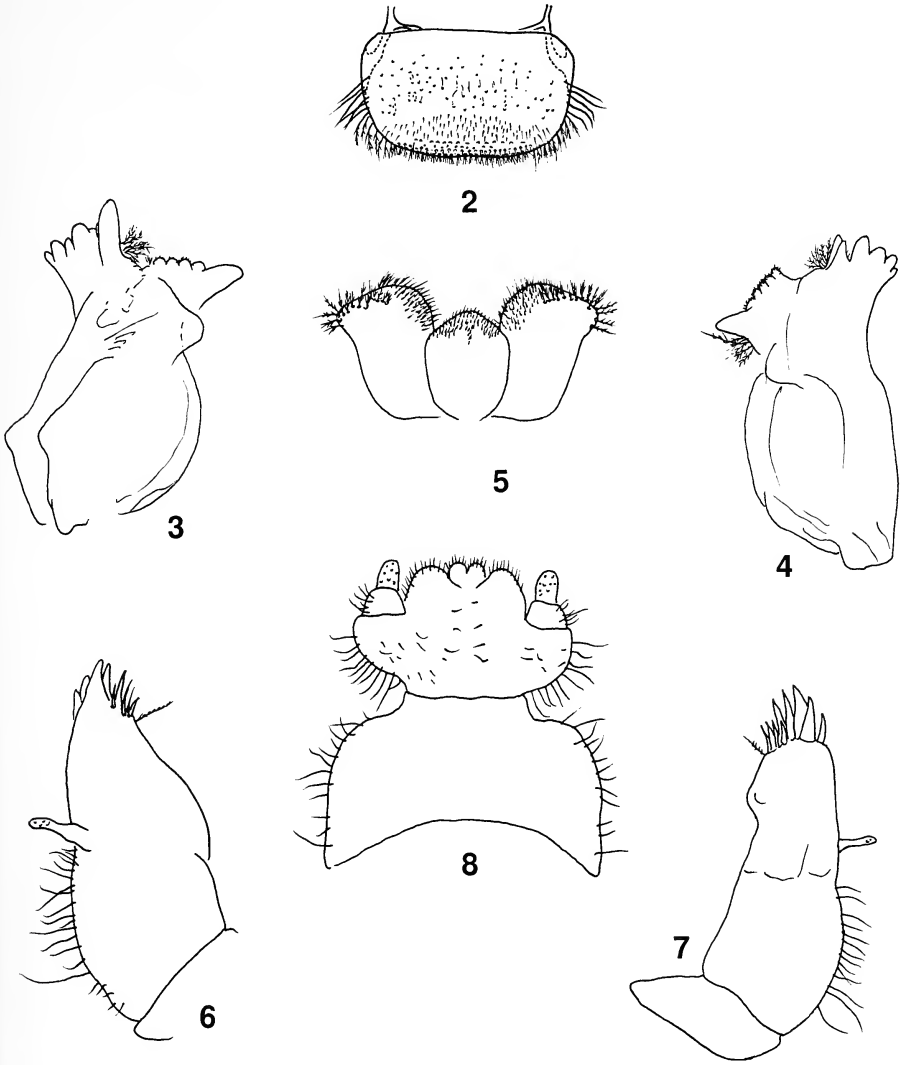
The genus *Crinitella* (Ephemeroptera: Ephemerellidae) is restricted to the Old World and has been treated at various taxonomic ranks. *Crinitella* was introduced as a monotypic subgenus (Allen and Edmunds 1963) within *Ephemerella*. In a review of the subfamilies of Ephemerellidae, Allen (1965) listed *Crinitella* as one of 11 subgenera of *Ephemerella*. Subsequently, Hubbard and Peters (1978) assigned three Pakistani species to this subgenus. *Crinitella* was later elevated to generic rank by Allen (1980). In a revision of Ephemerellinae, Allen (1984) listed *Crinitella* as one of 17 genera in the subfamily (one of which was later transferred to Teloganodidae [McCafferty and Wang, 1997]).

The four previously described species of *Crinitella* are *C. coheri* Allen & Edmunds, described from Nepal; and *C. nasiri* Ali, *C. swatensis* Ali, and *C. wahensis* Ali, described from Pakistan. In this paper, *Crinitella permkami* sp. nov. is described from southern Thailand, bringing the number of described species of the genus to five.

***Crinitella permkami*, new species** (Figs. 1–8)

Diagnosis. *Crinitella permkami* sp. nov. is closely related to *C. coheri* in general appearance, but it differs from the latter in its pattern of black coloration on the head, pronotum, femora, and gill 2, whereas, *C. coheri* is unicolorous. Further, the left mandibular molar surface of *C. permkami* sp. nov. is well developed, whereas that of *C. coheri* is reduced with a large anterior articulating condyle. In *C. permkami*





Figs. 2–8. (2) labrum, (3) right mandible, (4) left mandible, (5) hypopharynx, (6) right maxilla, (7) left maxilla, (8) labium.

←
Fig. 1. Habitus (dorsal) of *Crinitella permkami* sp. nov.

sp. nov., the apical segment of labial palp is longer than wide, whereas in *C. coheri*, the apical segment is wider than long.

Description. *Mature Larva.* Body color dark brown. Head with black band along compound eyes and ocelli; labrum less than two times as wide as long, anterior margin with short branched setae, lateral margin with long setae (Fig. 2); mandibles as in Figs. 3 and 4; hypopharynx with well developed superlinguae, linguae slightly pointed (Fig. 5); maxillae well developed, galea-lacinia with strong apical teeth (Figs. 6,7); labium with highly reduced glossae, paraglossae, and palpi (Fig. 8). Thorax and legs with long setae; legs with black maculae on the subapical posterior surface of femora; tarsal claws with a single tridentate projection and palisade of five to seven long denticles. Abdominal terga 3–7 with imbricated tracheal gills (Fig. 1), gill lamellae dark basally; abdominal terga with long setae on submedian surface of segments 1–8 (Fig. 1); a row of long hair on terga 4–8 mesad of the gills; abdominal sterna yellow-brown, with sublateral black spots, without hair. Caudal filaments light brown, subequal in length (Fig. 1).

Adult. Unknown.

Etymology. This species is named after Surakrai Permkam, Chair of the Pest Management Department, Prince of Songkla University, Hat Yai, Thailand, in honor of his contribution to the collection of this new species during a visit by RWS.

Discussion. This is the first record of the genus *Crinitella* from Thailand. The four other described species of the genus are known from Pakistan or Nepal (see Hubbard and Peters, 1978), thus this record represents a substantial southeastward extension of the known range of *Crinitella*. The only other species of Ephemerellidae recorded from Thailand are *Cincticostella boja* (Allen), *C. gosei* (Allen) [= *Serratella thailandensis* Allen (see Edmunds and Murvosh, 1995)], *C. insolta* (Allen), and *Ephacerella commodema* (Allen). Thus, the addition of *C. permkami* sp. nov. brings the number of described species of Ephemerellidae recorded from Thailand to five. This species was taken in five provinces that extend from Yala Province near the Malaysian border to as far north as Nakhonsithamarat Province.

Type locality. The holotype locality was a clear, unnamed stream approximately 8–10 m in width and approximately 0.5 m in depth at the deepest points in riffles with moderate current velocity. Erosional areas were deeper. Marginal emergent vegetation was present, although the riffles where *C. permkami* sp. nov. occurred were devoid of vegetation. The other streams in which this species was collected had similar habitat characteristics to those of the type locality, although some streams were slightly wider and deeper. Early in January 1998, separatist guerillas bombed the Hwy 401 bridge spanning the stream at the type locality. Thus, the present condition of the type locality is unknown.

Types. Holotype. THAILAND, **Yala Prov.**, stream outside entrance to Banglang National Park near Than To, 14.i.1995, Sites & Nichols, riffles in stream (mouthparts slide-mounted) (deposited: MU). Paratypes: THAILAND, **Yala Prov.**, same data as holotype, 5 specimens (3 PSU, 2 MU); **Satun Prov.**: Wangpachan District, Ton Bliw, 9.vii.1997, Sites & Permkam, rocky & sandy stream, 1 specimen (MU); **Songkhla Prov.**: Ton Nga Chang Nat. Pk., stream at Buddhist temple, 6.i.1995, Sites & Nichols, 1 specimen (MU); same locality, 7.i.1995, Sites & Nichols, 2 specimens (PSU); same locality, 8.i.1995, Sites & Nichols, 2 specimens (PU); same locality, 6.vii.1997, R. W. Sites, 20 specimens (5 RTA, 5 PSU, 10 MU).

Additional material examined. THAILAND, **Nakhonsithammarat Prov.**, Chawang Rd., ca. 8 km S. of Khao Luang Nat. Pk., roadside stream, 12.vii.1997, Sites & Permkam, 2 specimens (MU); stream from Khao Luang Nat. Pk., 12.vii.1997, Sites & Permkam, stream under bridge, 4 specimens (MU); **Songkhla Prov.**, Ton Nga Chang Nat. Pk., stream at Buddhist temple, 7.i.1995, Sites & Nichols, 1 specimen (MU); same locality, 6.vii.1997, R. W. Sites, 22 specimens (MU, PU, RTA); **Trang Prov.**, ca. 10 km E of Khao Ka Chong Nat. Pk. on Hwy 4, 12.i.1995, Sites & Nichols, 1 specimen (MU); **Yala Prov.**, Than To, Banglang Nat. Pk., 14.i.1995, Sites & Nichols, riffles in stream, 6 specimens (MU).

Type specimen repositories. Specimens of the type series are deposited in insect collections of the following institutions: University of Missouri-Columbia (MU), Prince of Songkla University (PSU), Royal Thai Agriculture Department (RTA); Purdue University (PU).

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LITERATURE CITED

- Ali, S. R. 1971a. Certain mayfly nymphs (Order: Ephemeroptera) of Azad Kashmir and Swat. Pakistan J. Sci. 23:209–214.
- Ali, S. R. 1971b. The nymphs of new species of genus *Ephemerella* (Order: Ephemeroptera). Pakistan J. Forestry. 21:359–366.
- Allen, R. K. 1965. A review of the subfamilies of Ephemerellidae (Ephemeroptera). J. Kansas Entomol. Soc. 38:262–266.
- Allen, R. K. 1980. Geographic distribution and reclassification of the Subfamily Ephemerellinae (Ephemeroptera: Ephemerellidae). In: J. F. Flannagan and K. E. Marshall (eds.), Advances in Ephemeroptera Biology. Plenum Publ. Corp., N.Y., 552 pp.
- Allen, R. K. 1984. A new classification of the subfamily Ephemerellinae and the description of new genus. Pan-Pac. Entomol. 60:245–247.
- Allen, R. K. and G. F. Edmunds, Jr. 1963. New and little known Ephemerellidae from southern Asia, Africa and Madagascar (Ephemeroptera). Pacific Ins. 5:11–22.
- Edmunds, G. F., Jr., and C. M. Murvosh. 1995. Systematic changes in certain Ephemeroptera studies by R. K. Allen. Pan-Pac. Entomol. 71:156–160.
- Hubbard, M. D. and W. L. Peters. 1978. A catalogue of the Ephemeroptera of the Indian Subregion. Oriental Ins. 9 (Suppl.):1–43.
- McCafferty, W. P. and T.-Q. Wang. 1997. Phylogenetic systematics of the family Teloganodidae (Ephemeroptera: Pannota). Ann. Cape Prov. Mus. (Nat. Hist.) 9:387–437.

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A NEW TROGLOMORPHIC SPECIES OF *ARRHOPALITES* (COLLEMBOLA: ARRHOPALITIDAE) FROM BRAZIL

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Abstract.—An eyeless new species of *Arrhopalites* from Brazilian caves is described, illustrated, and compared with other species.

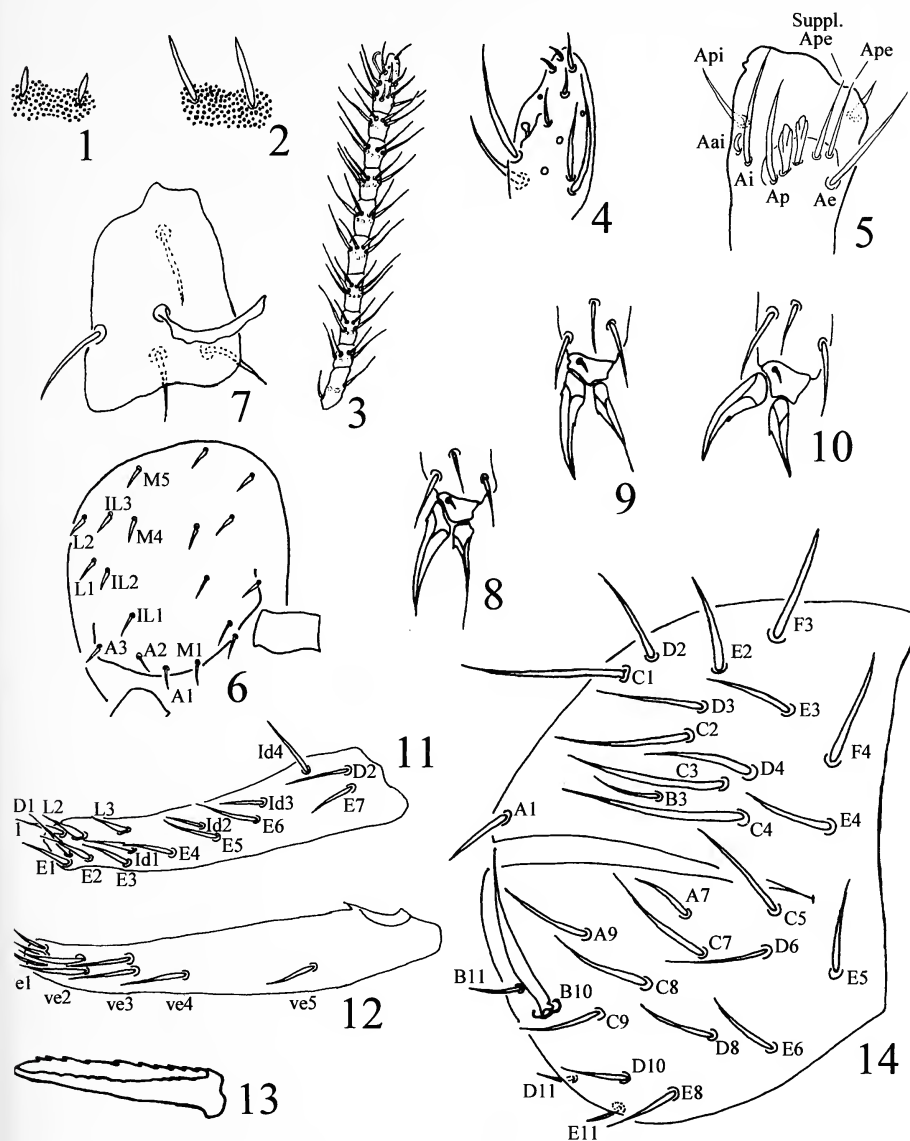
Key words.—*Arrhopalites*, Collembola, cave fauna, Neotropical Region.

The genus *Arrhopalites*, Börner 1906, is cosmopolitan, with more than 100 described species. The most recent contributions are those of Christiansen and Bellinger (1996) from the United States, Wu and Christiansen (1997) from China, and Palacios-Vargas and Zeppelini (1996) from the Neotropical Region. *Arrhopalites* as a whole has many adaptations to life in caves (troglomorphisms), including lack of pigment, reduction or lack of eyes, long antennae, and modification of foot structures that enable them to walk on water.

Herein we describe the chaetotaxy of head and dens of furcula following Christiansen (1966) and Christiansen and Bellinger (1998) respectively, apical sensory organ of the third antennal segment as Nayrolles (1991) and anal valve chaetotaxy following Lawrence (1979) and Christiansen and Bellinger (1998).

***Arrhopalites papaveroi*, new species** (Figs. 1–14)

Description. Body sparsely clothed with short setae on anterior part of the abdomen (Fig. 1) and broad setae (as long as unguis III) on posterior part of the abdomen (Fig. 2). Antennae of holotype about $1.8\times$ length of head. Ant. I: II; III; IV = 1: 1.3; 2.6; 7.3. Ant. I with 5 setae. Ant. IV $3\times$ longer than Ant. III and distinctly subdivided into 10 subsegments (Fig. 3); longest setae about $1.5\times$ width of segment; apical subsegment of Ant. IV with a capitate sense rod (Fig. 4). Ant. III without basal swelling; sense organ (Fig. 5) with 2 large apically-broadened parallel sense rods in separate shallow pits; seta Aai reduced and club-shaped, Api seta displaced ventrally, a supplementary Ape seta present. Eyes absent. Dorsal cephalic chaetotaxy lacking setae M2 and M3 (Fig. 6); all setae thick and spiniform but A1, A2 and IL1. Seta of trochanteral organ of the third leg fringed (Fig. 7). First unguis without inner tooth (fig. 8), second and third with a small inner tooth on basal half (Figs. 9 and 10). Tunica absent. First unguiculus with long apical filament, exceeding apex of unguis (Fig. 8), second with apical filament as long as unguis (Fig. 9), and third without apical filament (Fig. 10). Dens about $2.2\times$ length of mucro; 7 dorsal E setae,



Figs. 1–14. *Arrhopalites papaveri* new species. 1, anterior body setae; 2, posterior body setae; 3, Ant. IV; 4, apical subsegment of Ant. IV, showing the capitated sense rod; 5, sensory organ of Ant. III; 6, head chaetotaxy; 7, metatrochanteral organ seta; 8, First foot complex; 9, second foot complex; 10, third foot complex; 11, dorsal dental chaetotaxy; 12, ventral dental chaetotaxy; 13, mucro, dorsal-lateral view; 14, anal valve chaetotaxy, lateral view.

E1, E2 and E3 slightly thicker; 3 L setae, L1–3 thick but not spinelike; D1, D2 and id (1–4) are present (Fig. 11); ventral setae formula 3,2,2,1,1 (Fig. 12). Mucro narrow, gutter-like, conspicuously serrated on outer edge and almost smooth on inner (Fig. 13). Anal valve without spines or thick setae; setae B2, C6 and C11 absent, chaetotaxy as in figure 14. Female subanal appendage (seta B10) long and acuminate. Body length of the adult female holotype 0.45 mm, head 0.25 mm.

Variation. The specimen from Lago Azul cave has an abnormal mucro with both edges strongly serrate, and could represent another species.

Etymology. This species is named after Dr. Nelson Papavero, for his contributions to systematics in Brazil.

Type Material. Holotype, ♀, BRAZIL, **Mato Grosso do Sul**, Bonito, Cave João de Arruda, 03.vii.1998, D. F. Zeppelini (MZUSP). Paratypes: BRAZIL, **Mato Grosso do Sul**: 3 ♀, 1 ♂, 3 juveniles, same data as holotype except 1 ♀, BRAZIL, **Mato Grosso do Sul**, Bonito, cave João de Arruda, 18.x.1990, E. Trajano (MZUSP); 1 ♀, BRAZIL, **Mato Grosso do Sul**, Bonito, Cave Lago Azul, 19.vii.1991, E. Trajano.

Discussion. One of most distinctive features of *Arrhopalites papaveroi* is the lack of eyes. There are over 100 species in this genus and many live in caves, but very few are eyeless. This is the first species from the new world that lacks eyes and pigment. The other eyeless species are *A. pukouensis* Wu & Christiansen, 1997 from deep soils of China, and *A. antrobius* (Yosii, 1954) from Japanese caves. Another important feature is the presence of a supplementary Ape seta, which has been found in other undescribed Brazilian species that seem to belong to a monophyletic group. These species also share an unusual metatrochanteral organ. *Arrhopalites papaveroi* seems to be related to *A. christianseni*, *A. hennigius*, and *A. wallacei* (Palacios-Vargas and Zeppelini, 1996); all of which have long antennae, Ant. IV with more than 8 subdivisions, and lack setae B2 and C6 on the anal valve. The latter character seems to be synapomorphic to the Brazilian species which lack spines on the anal valve. The new taxon differs from these species and from other tropical forms by the characters listed in the following key. *Arrhopalites papaveroi* was referred to as *A. sp 2* in Zeppelini, 1997.

KEY FOR NEOTROPICAL SPECIES OF ARROPALITES

1. Ant. IV indistinctly subdivided. Anal valve with setae series C broad and slightly serrated, and 4 or 5 short cuticular spines on each side 5
- 1' Ant. IV clearly subdivided. Anal valve setae series C with normal setae, and without any spines 2
2. Ant. IV with 11 subsegments; 1+1 eyes *A. wallacei* (Palacios-Vargas and Zeppelini, 1996). Brazil
- 2' Ant. IV with less than 11 subsegments, 0 or 2+2 eyes 3
3. Ant. IV with 10 subsegments, 0+0 eyes, supplementary Ape seta on the sensorial organ of Ant. III *A. papaveroi* new species Brazil
- 3' Ant. IV with 9 subsegments, 2+2 eyes, no supplementary Ape seta 4
4. Ant. IV 3.5 times Ant. III; dental setae ve5 absent, anal setae C 2–4 thin; subanal appendage acuminate and not serrate *A. hennigius* (Palacios-Vargas and Zeppelini, 1996). Mexico
- 4' Ant. IV 2.5 times Ant. III, dental setae ve5 present, anal setae C 2–4 broad near the base, subanal appendage serrated and broadened at the tip *A. christianseni* (Palacios-Vargas and Zeppelini, 1996). Mexico

5. 1+1 eyes; less than 10 ventral setae on dens 6
 5' 2+2 eyes; 10 ventral setae on dens
 *A. amorimi* (Palacios-Vargas and Zeppelini, 1996). Brazil
 6. First unguis with tunica *A. vazquezae* (Palacios-Vargas & Zeppelini, 1996). Mexico
 6' First unguis without tunica 7
 7. Ungues II and III with tunica 8
 7' Ungues II and III without tunica 9
 8. Dental setae E1–4 spinelike; setae Ape and Api on apical organ of Ant. III short ...
 *A. gnaspinius* (Palacios-Vargas and Zeppelini, 1996). Brazil
 8' Dens with normal E setae; Ape and Api on Ant. III long
 *A. lawrencei* (Palacios-Vargas and Zeppelini, 1996). Brazil
 9. Ventral dental formula 3,2,2,1,1 *A. harveyi* (Denis, 1933). Costa Rica
 9' Ventral dental formula 3,2,1,1,1
 *A. millsii* (Delamare Deboutteville and Massoud, 1963). Argentina

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LITERATURE CITED

- Börner, C. 1906. Das System der Collembolen nebst Beschreibung neuer Collembolen des Hamburger Naturhistorischen Museums. Mitt. Naturhist. Mus. Hamburg, 23:147–188.
 Christiansen, K. 1966. The genus *Arrhopalites* (Collembola, Sminthuridae) in the United States and Canada. International Journal of Speleology. 2:43–73.
 Christiansen, K. and P. Bellinger. 1996. Cave *Arrhopalites* new to Science. J. Cave Karst Studies, 58:168–180.
 Christiansen, K. and P. Bellinger. 1998. The Collembola of North America, north of the Rio Grande. A taxonomic analysis. Grinnell College, Grinnell, Iowa. 1520 pp.
 Delamare Deboutteville, C. and Z. Massoud. 1963. Collembolles Symphypléones. Biol. Amer. Australe. 2:169–289.
 Denis, J. R. 1933. Contributo alla conoscenza del “microgenton” di Costa Rica, III. Collembolles de Costa Rica avec une contribution au species de l'ordre (deuxieme note). Boll. Lab. Entomol. Agr. Portici. 27:222–322.
 Lawrence, P. N. 1979. The terminology of terminalia and cartography of chaetotaxy in the Collembola, its evolutionary significance and systematic utility. First International Seminar Apterygota, Siena. 69–80.
 Nayrolles, P. 1991. La chétotaxie antennaire des collembolles symphypléones. Trav. Lab. Eco-biol. Arth. Édaph. Toulouse. 6(3):1–94.
 Palacios-Vargas, J. G. & D. Zeppelini. 1996. Seven new *Arrhopalites* (Hexapoda: Collembola) from Brazilian and Mexican caves. Folia Entomol. Mex., 93:7–23.
 Wu, M. and K. Christiansen. 1997. A new species of *Arrhopalites* from China (Collembola: Sminthuridae). Fla. Entomol. 80(2):266–269.
 Yosii, R. 1954. Höhlencollembolen Japans I. Kontyû 20:62–70.
 Zeppelini, D. F. 1997. Some comments on *Arrhopalites* (Collembola) phylogeny, biogeographic evolution of cave fauna, and optimization of cave adaptive features. J. Comp. Biol. 2(2): 121–128.

NOTES AND COMMENTS

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RESOURCE DEPENDENT LARVIPOSITION BEHAVIOR OF A PITCHER PLANT FLESH FLY, *FLETCHERIMYIA FLETCHERI* (ALDRICH) (DIPTERA: SARCOPHAGIDAE)

Several studies have focused on the pitcher plant flesh fly, *Fletcherimyia fletcheri* (Aldrich), due to its unique biology (Fish and Hall, 1978; Forsyth and Robertson, 1975; Judd, 1959; Lloyd, 1942; Swales, 1969, 1972). In brief, what is known is that *F. fletcheri* females larviposit first instar larvae, usually singly, into the newest leaves of the northern pitcher plant, *Sarracenia purpurea* L., starting at the beginning of June. *Fletcherimyia fletcheri* larvae feed on dead insects floating at the water-air interface in pitchers. The larvae are territorial and attempt to kill each other during encounters, usually resulting in a distribution of one larva per pitcher. Larval development, consisting of three instars, is completed within the leaves of the northern pitcher plant. At the conclusion of larval development, *F. fletcheri* larvae crawl from the leaves and pupate in the sphagnum moss below pitcher plants (Forsyth and Robertson, 1975).

I tested whether *F. fletcheri* larviposition choices were affected by the presence and quality of prey in leaves of *S. purpurea*. To meet this objective, whole prey (house flies), crushed prey (crushed house flies), or no additional prey were added to new pitchers in the field, and subsequent occupation of pitchers by *F. fletcheri* was censused.

MATERIALS AND METHODS

Study site. This experiment was conducted from 25 July to 1 August 1996 at Brighton Bog (44°26'50"N, 74°12'52"W) in the Adirondack Preserve of New York State just north of Paul Smiths in Franklin County. Brighton Bog is a large quaking bog (approximately 2 ha in size) with an open pond at the northwestern edge. The bog mat consists primarily of *Sphagnum* sp. moss and does not support the growth of tall vegetation. The bog is within a forest dominated by white pine (*Pinus strobus* L.), tamarack (*Larix laricina* (DuRoi)), and occasional deciduous trees. Plants found growing at the edges of the bog during different parts of the season included leather leaf (*Chamaedaphne calyculata* (L.)), sheep laurel (*Kalmia augustifolia* L.), labrador tea (*Ledum groenlandicum* Oeder), and bog rosemary (*Andromeda glaucophylla* Link). In addition, cotton grass (*Eriophorum polystachion* L.) flourished in the center of the bog during late summer and into early fall. *Sarracenia purpurea* L. plants were the most abundant during this study at the perimeter of the bog.

Prey addition experiment. The perimeter of Brighton Bog containing the highest densities of *S. purpurea* plants was subdivided into eighteen locations. Seven out of the eighteen locations were chosen randomly to set up the prey addition experiment.

On 25 July, three pitcher plants (closely situated to each other) at each of the seven locations were selected, and the contents of the newest pitcher on each plant (determined by choosing the pitcher originating from the center of a leaf whorl, as in Fish and Hall, 1978) were removed using a suction device consisting of a plastic 15 ml elongate tip syringe (with tip removed) with an attached piece of tygon tubing (see Rango, 1999 for details). The newest pitcher on each plant was used to minimize age differences among pitchers. Individual pitchers at each location were filled with distilled water and then randomly assigned to one of the following prey addition treatments: addition of (1) 10 whole, freeze-killed *Musca domestica* L. house flies every other day from 25–31 July, (2) 10 crushed, freeze-killed *M. domestica* house flies every other day from 25–31 July, and (3) no *M. domestica* (control). For treatment 2, forceps were used to crush house flies so that body contents were more readily available for consumption by *F. fletcheri* larvae. Crushed house flies were hypothesized to be higher quality prey than whole house flies because they could be more easily eaten by flesh fly larvae. On 1 August, all contents of each pitcher were again removed using the suction device, larvae present in pitchers were counted, and contents were then poured back into pitchers. A sample of the larvae was retained so that identifications could be made later in the laboratory. Larvae were identified as *F. fletcheri* using Courtney et al., 1996.

A preliminary survey of *S. purpurea* leaves on Brighton Bog showed that 10.38 ± 8.35 (mean \pm SD) prey items were captured by the newest leaves on 24 pitcher plants over a two week period (29 June–12 July 1996). Thus, experimental pitchers with supplemented house flies had greatly enhanced quantities of prey over natural levels.

Statistical analyses. The data collected, numbers of flesh fly larvae in experimental pitchers, were transformed using the Freeman and Tukey transformation, $\sqrt{\text{count} + \sqrt{\text{count} + 1}}$ (as cited by Sokal and Rohlf, 1995), to normalize the data and stabilize variances in statistical tests. The Freeman and Tukey transformation is appropriate for data that consists of counts including zero values. A one-way ANOVA performed on transformed numbers of flesh fly larvae was used to determine whether the number of larvae surviving in pitchers (arranged in a randomized block design) was affected by the prey addition treatments. *Post hoc* contrasts were used to distinguish the source of differences among prey addition treatments.

RESULTS

Higher numbers of flesh flies were found in pitchers with added prey than with no additional prey (control) at the end of the eight day prey addition experiment (Fig. 1; Table 1; control < whole prey, crushed prey; *post hoc* comparison $F_{1,12} = 7.35$, $P = 0.02$). This difference in larval flesh fly density among prey addition treatments was visually distinct. Some pitchers with added prey were inhabited by five flesh fly larvae of various sizes, whereas control pitchers never contained more than one larva. Numbers of flesh flies in pitchers were not different between whole prey and crushed prey addition treatments (*post hoc* comparison $F_{1,12} = 0.73$, $P = 0.41$).

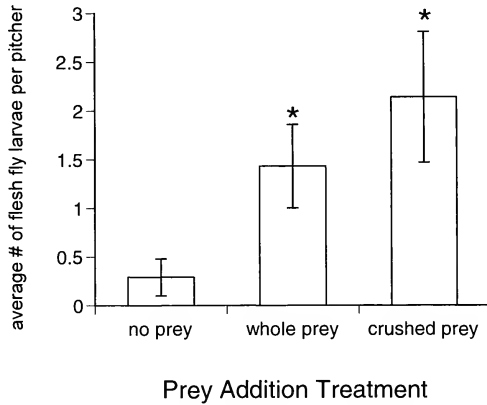


Fig. 1. Mean number (± 1 SE) of flesh fly larvae in no additional prey (control), whole prey, and crushed prey treatment pitchers sampled at the end of an eight day prey addition experiment (25 July–1 August 1996) performed on Brighton Bog, Paul Smiths, NY. Note: *indicates significant difference from control.

DISCUSSION

The higher numbers of flesh flies in pitchers supplemented with prey compared to no additional prey suggests that *F. fletcheri* show a resource dependent larviposition behavior. Larvipositing females may preferentially cue in on pitchers with high prey levels. Habitat assessment during larviposition or oviposition is common among Diptera. For example, mosquitoes make oviposition choices using visual, tactile, chemotactile, and olfactory cues (Bentley and Day, 1989). In this experiment, pitchers with the highest numbers of flesh fly larvae contained several decomposing house flies floating on the surface of the water giving off a putrid stench. At least one other species of sarcophagid (*Sarcophaga (Neobellieria) bullata* Parker) is known to orient olfactorily to oviposition sites (Cole Gilbert, pers. comm.). Females of *F. fletcheri* may be attracted to the smell of decomposing insect prey (olfactory cue) or chemical constituents in the pitcher fluid associated with high levels of decomposition (chemotactile cue).

The quality of prey in pitchers, at least in terms of whole prey versus crushed prey, did not affect how many *F. fletcheri* larvae occupied pitchers. Crushed house

Table 1. One-way ANOVA comparing $\sqrt{\text{count}} + \sqrt{\text{count} + 1}$ transformed numbers of flesh fly larvae occurring in pitchers receiving different prey treatments (addition of whole prey, crushed prey or no prey (control)) sampled at the end of an eight day prey addition experiment (25 July–1 August 1996). Treatments were set up in a randomized block design across Brighton Bog, Paul Smiths, NY

Source	Sum of Squares	Degrees of Freedom	F Test	P value
Block	5.248	6	0.751	0.621
Prey Treatment	9.423	2	4.043	0.045
Error	13.984	12		

flies may not be perceived as different from whole house flies by larvipositing *F. fletcheri* females. The mere presence of abundant prey in pitchers, regardless of condition (i.e., more or less accessible to feeding larvae), may be enough to stimulate larviposition by *F. fletcheri* females. However, experiments with varying prey types and quantities would be necessary to test this hypothesis.

A resource dependent larviposition behavior may be evolutionarily advantageous to *F. fletcheri*. In particular, the aquatic microcosms supported by *S. purpurea* leaves have been shown to be resource limiting to the larvae of both the pitcher plant mosquito, *Wyeomyia smithii* (Coquillett) (Diptera: Culicidae), and the pitcher plant midge, *Metriocnemus knabi* (Coquillett) (Diptera: Chironomidae) (Bradshaw, 1983; Farkas and Brust, 1985; Heard, 1994; Istock et al., 1975). In addition, studies have shown that more than one flesh fly can exist in the same artificial microcosm only at high food levels, suggesting that *F. fletcheri* larvae may also be resource limited in nature. Consequently, a resource dependent larviposition behavior may help ensure that *F. fletcheri* larvae are placed into habitats with the highest food levels leading to maximum larval survival.—*Jessamy J. Rango, Department of Entomology, Cornell University, Ithaca, New York 14853-0901; present address: Department of Biology, P.O. Box 871501, Arizona State University, Tempe, AZ 85287-1501.*

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LITERATURE CITED

- Bentley, M. D. and J. F. Day. 1989. Chemical ecology and behavioral aspects of mosquito oviposition. *Annual Review of Entomology* 34:401–21.
- Bradshaw, W. E. 1983. Interaction between the mosquito *Wyeomyia smithii*, the midge *Metriocnemus knabi*, and their carnivorous host *Sarracenia purpurea*. pp. 161–189 in: *Phytotelmata: terrestrial plants as hosts for aquatic insect communities*. J. H. Frank and L. P. Lounibos (eds.). Plexus, New Jersey.
- Courtney, G. W., R. W. Merritt, H. J. Teskey and B. A. Foote. 1996. Aquatic Diptera: larvae of aquatic Diptera. pp. 484–548 in: *An introduction to the aquatic insects of North America*, 3rd edition. R. W. Merritt and K. W. Cummins (eds.). Kendall/Hunt Publishing Company, Dubuque, Iowa.
- Farkas, M. J. and R. A. Brust. 1985. The effect of a larval diet supplement on development in the mosquito *Wyeomyia Smithii* (Coq.) under field conditions. *Canadian Journal of Zoology* 63:2110–2113.
- Fish, D. 1983. *Phytotelmata: flora and fauna*. pp. 1–28 in: *Phytotelmata: terrestrial plants as hosts for aquatic insect communities*. J. H. Frank and L. P. Lounibos (eds.). Plexus, New Jersey.
- Fish, D., and D. W. Hall. 1978. Succession and stratification of aquatic insects inhabiting the

- leaves of the insectivorous pitcher plant, *Sarracenia purpurea*. American Midland Naturalist 99:172–183.
- Forsyth, A. B. and R. J. Robertson. 1975. K reproductive strategy and larval behavior of the pitcher plant sarcophagid fly, *Blaesoxipha fletcheri*. Canadian Journal of Zoology 53: 174–179.
- Heard, S. B. 1994. Pitcher-plant midges and mosquitoes: a processing chain commensalism. Ecology 75:1647–1660.
- Istock, C. A., S. S. Wasserman and H. Zimmer. 1975. Ecology and evolution of the pitcher-plant mosquito: 1. Population dynamics and laboratory responses to food and population density. Evolution 29:296–312.
- Judd, W. W. 1959. Studies of the Byron Bog in southwestern Ontario X. inquilines and victims of the pitcher-plant, *Sarracenia purpurea* L. The Canadian Entomologist 91:171–180.
- Lloyd, F. E. 1942. The carnivorous plants. The Ronald Press Company, New York, New York.
- Rango, J. J. 1999. Summer phenology of aquatic insect communities inhabiting the leaves of the northern pitcher plant, *Sarracenia purpurea* L. Northeastern Naturalist 6(1):19–30.
- Sokal, R. R. and F. J. Rohlf. 1995. Biometry, 3rd edition. W. H. Freeman and Company, New York, New York.
- Swales, D. E. 1969. *Sarracenia purpurea* L. as host and carnivore at Lac Carre, Terrebonne CO., Quebec. Naturaliste Canadien 96:759–763.
- Swales, D. E. 1972. *Sarracenia purpurea* L. as host and carnivore at Lac Carre, Terrebonne CO., Quebec. Part II. Naturaliste Canadien 99:41–47.

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NEST MATERIAL REUSE BY *PARACHARTERGUS* R. VON IHERING (HYMENOPTERA: VESPIDAE)

Social wasps (Vespidae) construct their nests of vegetable fiber (a few tropical species utilize mud). Using water to soften the fibers at the source, foragers use their mandibles to scrape up a wad of wet pulp, which is carried back to the nest. The mass is mixed with a salivary adhesive and formed into the cells and envelope. The adhesive secretion forms a thin matrix that binds the fibers together and confers a water repellency to the finished carton.

Nest construction and maintenance is dangerous since it requires numerous trips of workers for material location and transportation (Jeanne, 1986). Nevertheless few species reprocess nest material from one part of the nest for use in other parts during normal nest expansion. *Belonogaster* and *Vespula* spp. tear down inner layers of envelope for use in constructing new cells (Gadagkar, 1991, Greene 1991; Wenzel, 1991). Nest material reuse has also been found in several *Polistes* species as *P. annularis* (L. 1763), *P. metricus* Say, 1831 in the United States, *P. olivaceus* (Degeer, 1773) in Madagascar, *P. dominulus* (Christ, 1791) in Europe (Wenzel, pers. comm).

However, to date few species have been reported to salvage material from an

abandoned nest for use in new construction. Richards & Richards (1951) say for *P. fraternus*, "The wasps were busily engaged in eating away the old envelope, of which about one-third had already gone by 9.0 a.m. The material was being used to build the new nest."; perhaps this is the only published reference. When nests are abandoned, they are left to weather away and converted into habitat for other animals. I now report that *Parachartergus*, a Neotropical swarm-founding species, is an exception to this rule. I observed this behavior in *P. fraternus* and in *P. colobopter* in Colombia. Wasps were determined using the keys in Richards (1978). Vouchers have been deposited in the collection of the Instituto de Ciencias Naturales of the Universidad Nacional de Colombia, Santafé de Bogotá (ICN-MHN).

An active colony of *P. fraternus* was observed in December, 1995, in the rain forest of the Sierra Nevada de Santa Marta, Magdalena (11°5'5"N, 73°55'00"W) at an elevation of 1,100–1,200 m. The nest was constructed on the trunk of a *Bactris macana* (Mart.) Pittier palm 1.8 m above the ground. The envelope was 60 cm in length, including the long downward-extending entrance tube. The carton of the envelope was typical of the species (Richards 1978), dark gray in color with corrugations running perpendicular to the longitudinal axis at the center. The entrance had oblique corrugations.

Early in the morning of the day after discovery, I found the nest with its envelope torn widely open and several of the 10 combs missing, strongly suggesting attack by a vertebrate during the night. The adult wasps were gone, but during the day wasps were observed to arrive at the nest, cut pieces from the envelope, and chew these into masses of pulp. I was unable to see if these wasps wet the surface of the carton with water to soften it before removal but the appearance was of a rather maleable and darker material than the original. All laden wasps flew off in the same direction, evidently to where the swarm was constructing a new nest. I saw a maximum of three wasps in the nest at the same time. As with *P. fraternus* colonies in Costa Rica, they salvaged the envelope but left the combs intact (Bouwma, A. pers. comm.).

The colony of *P. colobopter* was discovered in January, 1998, in disturbed rain forest in a the private natural park of Rio Claro, San Luis, Antioquia (6°2'40"N, 75°00'00"W) at an elevation of 410 m. The nest was 3 m up on the trunk of a tree (40 cm diameter). The envelope was 27 cm long by 16 cm wide, reddish-brown in color and with irregular corrugations, not ridged, conforming to the published descriptions (Richards, 1978).

On April 10, 1998, the nest was raided by a colony of *Eciton hamatum* (Fabricius, 1804), forcing the adult wasps to abandon it. By 1500 hr the ants had removed all larvae from the nest and only one or two ants were still on the nest. By the next day wasps were seen to arrive at the nest and cut pieces of envelope in the same manner as described for *P. fraternus*. By that evening, they had succeeded in salvaging about 30% of the envelope. The nest contained twelve combs, including some formed from the fusion of two. Almost all combs contained cells with meconia, indicating that the nest had produced adult offspring.

Why do colonies of *Parachartergus* salvage material from their abandoned nests, while virtually all other tropical species use only new material? There is considerable variability among species with respect to the durability of their nest carton. The carton produced by *Parachartergus* is particularly tough. Nests can be occupied for

up to 16 years (Starr, 1976; Jeanne, 1980; Turillazzi, 1980; García, 1978). Examined under a stereomicroscope, the fibers from the envelope of the *P. colobopterus* nest described above were long and uniform, appearing to have come from a single type of plant source. Perhaps such long fibers are costly to extract from their source, yet are durable, making salvaging them from abandoned nests a less-costly process than collecting the raw material.—Carlos E. Sarmiento-M. M. Sc., Fundación Nova Hylaea, A. A. 52656, Santafé de Bogotá, D.C., Colombia, S.A., E-mail: cesarmiento@yahoo.com.

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LITERATURE CITED

- García, R. 1978. Cuatro estudios sobre las avispas sociales del Perú (Hymenoptera, Vespidae). Rev. Per. Ent. 29:25–28.
- Gadagkar, R. 1991. *Belonogaster*, *Mischocyttarus*, *Parapolybia* and independent-founding *Ropalidia*. 149–190. In: Ross, K. and R. Matthews (eds.). The social biology of wasps. Comstock Publishing Assoc. Ithaca.
- Greene, A. 1991. *Dolichovespula* and *Vespula* pp. 263–308. In: Ross, K. and R. Matthews (eds.). The social biology of wasps. Comstock Publishing Assoc. Ithaca.
- Jeanne, R. 1980. Observações sobre limpeza e reutilização de células em ninhos de vespas sociais (Hymenoptera, Vespidae). Bol. Mus. Par. Emílio Goeldi. (n. s.) 101:1–8.
- Jeanne, R. 1986. The organization of work in *Polybia occidentalis*: costs and benefits of specialization in a social wasps. Behav. Ecol. Sociobiol. 19:333–341.
- Jeanne, R. 1991. The swarm-founding Polistinae. pp. 191–231. In: Ross, K. and R. Matthews (eds.). The social biology of wasps. Comstock Publishing Assoc.
- Richards, O. 1978. The social wasps of the Americas excluding the Vespinae. Brit. Mus. (Nat. Hist.). London.
- Richards, O., and M. J. Richards. 1951. Observations on the social wasp of South America (Hymenoptera: Vespidae). Trans. Ent. Soc. Lond. 102:1–170.
- Starr, C. 1976. Nest reutilization by *Polistes metricus* (Hymenoptera: Vespidae) and possible limitation of multiple foundress associations by parasitoids. J. Kansas Ent. Soc. 49(1): 142–144.
- Turillazzi, S. 1980. Use of artificial nests for rearing and studying *Polistes* wasps. Psyche 87: 131–140.
- Wenzel, J. 1991. Evolution of nest architecture. pp. 480–519 In: Ross, K. and R. Matthews (eds.). The social biology of wasps. Comstock Publishing Assoc. Ithaca.

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INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

Manuscripts should be submitted in triplicate to: Dr. Dan A. Polhemus, Editor, Journal of the New York Entomological Society, Department of Entomology, National Museum of Natural History, MRC 105, Smithsonian Institution, Washington, DC 20560. Contributions must be written in English, double-spaced (including references, tables, captions, etc.) and prepared in the format of a recent issue of the Journal. Manuscripts of any length will be considered for publication. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

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Illustrations (originals whenever possible) should be submitted flat, never rolled or folded, with the manuscript. Size of illustrations should be kept manageable and suitable for shipment through the US mail without being damaged. Proportions of illustrations should conform to single column format, actual page size 11.5×17.5 cm. Please assemble illustrations in a compact fashion in order to use journal space effectively. *Mount line drawings and halftones on separate plates.* Figures should be numbered consecutively. Figure captions should be double-spaced, grouped together and placed at the end of the manuscript. If tables are submitted for photographic reproduction, they should be neat and clean and conform to journal format proportions.

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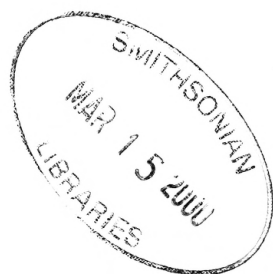




Fig. 1. John T. Polhemus at Lawrence, Kansas; April 1985.

A NATURAL SELECTION: 48 YEARS WITH JOHN T. POLHEMUS

IRMA R. POLHEMUS

3115 S. York St., Englewood, Colorado 80110

Many years ago I attended my one and only science class. The instructor spoke of the Age of Reptiles and the Age of Mammals, and told us the next group to dominate the world would be the insects; I believed him, but I didn't realize it would be so quick, or so personal.

I met John Polhemus in 1952 in his home town of Ames, Iowa. I had just been hired as a staff artist and cartoonist for WOI-TV, the country's first public television experiment at Iowa State College. It was my first week on my first job and I was feeling very shy and insecure. As I crouched over my drawing board trying to be invisible, a tall, breezy young man walked in and asked for me by name. He strode over to my desk and said "I'm John Polhemus. My mother would like you to come to dinner. What time do you leave work?" "4:30," I murmured. "Fine!" he said "I'll pick you up at 4:30." and he left. I didn't know him and I didn't know his mother, but I went.

It shouldn't have worked. As we later determined, he thought I was the skinniest woman he'd ever seen and I thought he was the most egotistical man I had ever met, but I made him laugh and he opened up for me a wonderful world of adventure. Beginning at 4:30 on that Thursday afternoon we have shared every subsequent day of the following 48 years unless separated by travel.

John was born in Ames, Iowa on September 11, 1929, the youngest of three boys. His father, George, was the head of the maintenance department of the Iowa Highway Commission, a job involving constant travel to insure that all state vehicles were repaired and running. John's mother, Elsie, was a former school teacher, a lady of intimidating energy and intelligence. Raised and educated in Pennsylvania, she spent several years in the Midwest before shrugging off the limits of her predictable world and answering an advertisement pleading for teachers in Hilo, Hawaii, quite an adventure in 1919. She arrived, as she later explained, on a boatload of 40 teachers and 40 mules. George, whom she had met while teaching in Ames, followed her a year later and secured a job on a sugar plantation. They were married on the side of Mauna Loa volcano. Who knows what tack John's life might have taken if the failure of the sugar crop the following year had not forced them back to the confines of the American Midwest, first to George's childhood home in spartan western Nebraska, and then to Iowa.

Growing up in Ames, Iowa, in the 1930s was to grow up in a traditional world of security and order soon to be permanently altered by war and technology. John's parents had the foresight to buy a modest, wooded acreage with a small frame house just on the edge of this civilized, self-contained college town. There was space for a sizeable vegetable and flower garden, a tiny stream flowed through a steep gully behind the buildings providing a spot for small boys to tinker and explore, and the



Fig. 2. A young John T. Polhemus, left, and his childhood friend Terry Smith, right, in John's bedroom in Ames, Iowa, circa 1947. Despite the obvious early interest in chemistry, one can see the beginnings of entomological inquiry as well, in the form of a case pinned insects near the left hand side of the picture.

house was expanded over the years to accommodate the growing family. Walk 8 blocks to the east and you were in the middle of the college. Walk 2 blocks to the west toward the hills and you were quickly enclosed by the still-unspoiled tall trees, wild flowers, and green thickets of the West Woods wildlife reserve. There were streams and ponds in the West Woods, and there were bugs in the streams. Just the thing to intrigue a curious, restless child. When John found an interesting water or shore bug he would take it to the college office of Dr. Carl Drake, a leading American heteropterist, who was always kind and informative.

Another of John's youthful enthusiasms was chemistry. He and his friend Terry Smith set up a formidable chemistry laboratory in John's bedroom. Once again, the college provided stimulation. Dr Brown of the chemistry department soon found John becoming a fixture in his laboratory. Bemused by this boy's curiosity and growing expertise he eventually assigned him projects and treated him as a useful assistant. Predictably, this personal world of exploration became more interesting than the mandated world of education and John began spending days trailing and questioning professors who seldom bothered to wonder why this child was in their offices and not in class. John's mother, in contrast, was constantly besieged by calls from the Ames public school system saying her son was nowhere to be seen.

John's father, over the years, had become fascinated with bee keeping, setting up colonies in surrounding rural areas and converting the garage into a processing plant. Forest Glen Apiaries was soon a bustling small business, and all family hands were required to keep it operating. When America went to war in 1941, sugar rationing increased the demand for honey. Soon both John's older brothers, Martin and Dale, were called to military service, and John's early teen age years were busy indeed as the only remaining helper.

At about this time, John and another good friend, Eddie Uhl, began to build their own private telephone system. Confronted with the problem of stretching wires over a considerable distance they devised a practical solution. They would simply shinney up the poles and utilize the already in-place wires of the Chicago & Northwestern Railroad. Unfortunately, in the process, they unwittingly managed to short out a section of the railroad's block signal system, creating chaos in this central link of America's transcontinental railroad corridor, which was transporting troop trains and war materials from coast to coast. There was panic in Washington. Trains were halted and agents sent to track down the source of the sabotage. An observant professor, in the course of his daily walk, had noticed the boys climbing the phone poles and mentioned this to the authorities. John, totally unaware of what chaos he had wrought, found himself called out class and summoned to the principal's office, where he was confronted not only by the grim local police chief but also a contingent of investigators from both the railroad and the FBI. He readily admitted to the project and handed over the remaining roll of wire. The local police chief was all in favor of sending both boys to the state reformatory, but fortunately the FBI was more compassionate, recognizing this was not willfull mischief; they were reprimanded and released to their parents.

Later in his high school years, John and his friend Johnny Hainer spent a summer in Idaho working on *Ribes* eradication in the national forests. Having no money for train fare, the boys simply hopped a freight, an effective but not necessarily safe or recommended mode of transportation. On arrival, their task was to spend every day running briskly up and down the mountains identifying the offensive *Ribes* bushes. They came back trim and tan, but John narrowly missed early extinction when he walked through the swinging doors of a saloon and was struck square in the middle of the forehead by a beer bottle thrown by one angry customer at another, who ducked.

In spite of all the distractions, John did graduate from Ames High School in 1947 and enrolled at Iowa State College (now Iowa State University), intending to pursue a degree in chemistry. However, as he later explained it, "The time was not right." He dropped out after one quarter and experimented with driving a truck for a construction company, working at a fish hatchery, fighting forest fires in California, and enlisting for a 4 year stint in the U.S. Air Force before eventually returning to begin his second quarter.

The years in the Air Force were a turning point. His first intention, after basic training, was to volunteer as a paratrooper to be dropped behind the enemy lines in Korea. Fortunately, he reconsidered, and the Air Force, recognizing intellectual potential, assigned him to be trained in the then-new field of radar. He spent the remainder of his four years in the service at Keesler Air Force Base in Biloxi, Mississippi, teaching radar during the day and spending his free time canoeing and

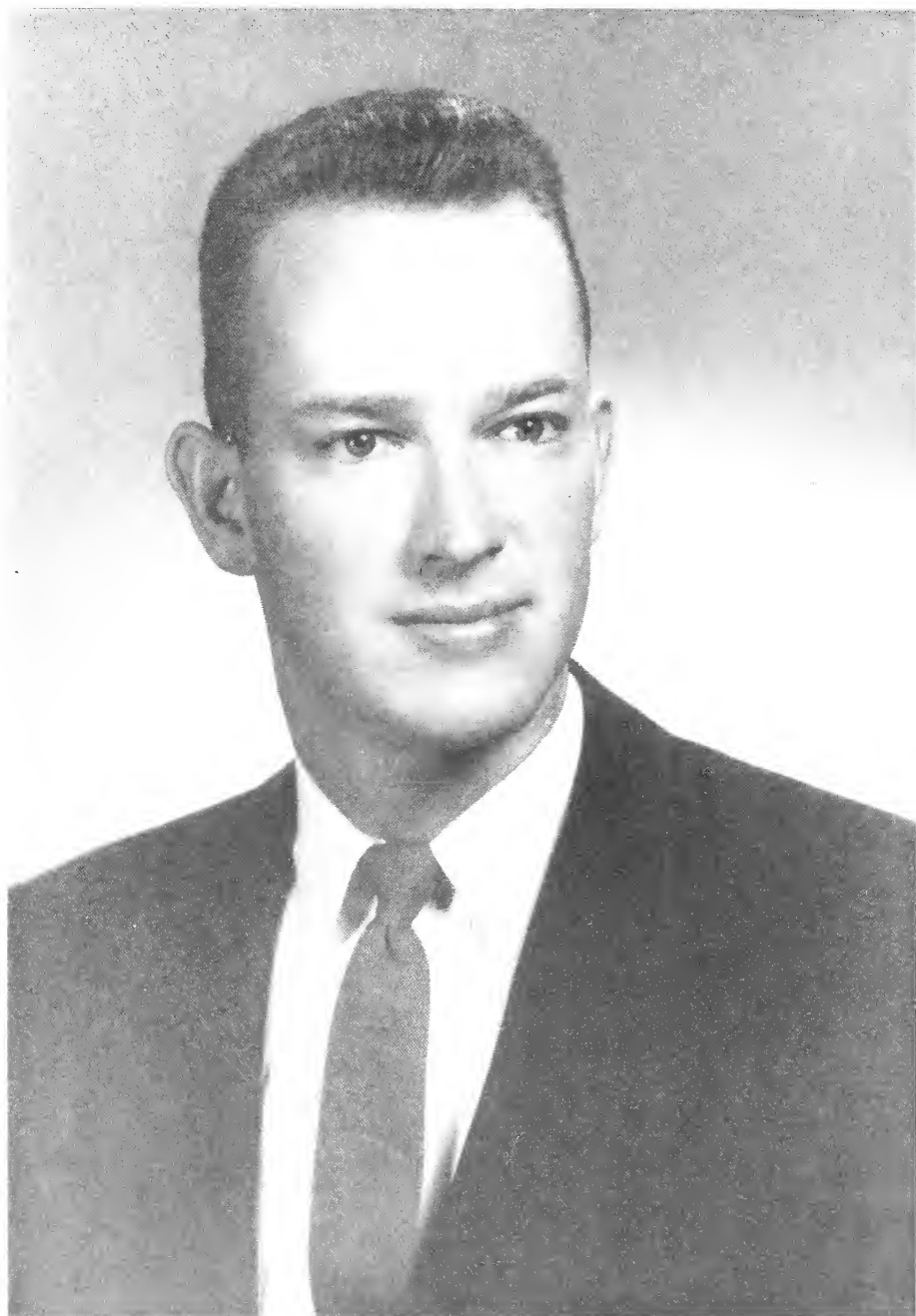


Fig. 3. John T. Polhemus as he appeared in his college graduation picture from Iowa State University, in 1956. By this time in his life he had already made good friends with heteropterist Carl Drake, who was for many years the chairman of the entomology department at Iowa State. John's first peer-reviewed paper in entomology would be published eight years later, in 1964.

perfecting his bass fishing technique at a primitive fishing camp in the Pascagoula swamp, one of his fondest recollections.

In 1952 the time was finally right for a return to college. His Air Force experience with electronics, plus the lure of good wages in this newly expanding field, persuaded him to change his major to Electrical Engineering. It was a good choice, resulting in over 30 years of challenging research and a number of patents. During these remaining college years John spent several summers as a Fire Guard in Yellowstone National Park, where his travails in packing equipment into remote wilderness camps fueled a permanent hatred of horses.

On June 12, 1955, John and I were married in the small brick church in my hometown of Peterson, Iowa and spent a week-long honeymoon canoeing in northern Minnesota and Canada. Back in Ames, one more year of intensive study allowed John to graduate in the spring of 1956 with honors, including Iowa Academy of Science Honor Roll, Phi Kappa Phi, Tau Beta Pi and Eta Kappa Nu.

Now a new life began with his acceptance of a position with California Research Corporation (CRC) in La Habra, California. Never one to waste an opportunity, John shunted us from Iowa to California by way of a two week camping trip through the Black Hills, Yellowstone and Glacier National Parks, into Canada to Banff and Lake Louise, and down the west coast from the Olympic Peninsula to Mt. Rainier, San Francisco, the Mojave desert and eventually, Los Angeles. This was quite an experience for me. I had never before seen either mountains or desert and as far as the camping was concerned, my family didn't even go on picnics!

CRC was the research arm of Standard Oil of California. For the next 4 years John happily immersed himself in work, including research on the first mass spectrometer. On weekends and holidays we explored the coast and the Sierras. On May 31, 1958 our first son, Dan Avery was born. A few months later, Standard Oil sent us on a field trip; four months in New Orleans and two more in Midland, Texas. Returning to California we became increasingly concerned with the smog and congestion in Los Angeles. In our various treks back and forth to visit relatives in the Midwest we had on several occasions crossed Colorado, and both of us had fallen in love with the state. On one particularly smoggy evening, driving back over the San Gabriel mountains into the L.A. basin, we looked at each other and said "This is it." John resigned his position with Cal Research, much to the distress of his supervisor, and we packed our child and our gear and headed for Denver. John had no job, but knew a number of potential employers to check out. Within a week he was hired by the electronic research department of Martin-Marietta. Within two months we had purchased a house and two weeks later, on December 6, 1960, our second son, John Martin was born.

You may notice that up to this point there has been little mention of aquatic Heteroptera. On the resume he compiled upon completing college, entomology was listed under "Hobbies" just behind hunting and fishing and just ahead of stamp collecting. I was totally naive and unsuspecting. When we were first married John had just one Schmidt box of bugs, and I had no idea what lay in store. During our excursions in the California countryside he began picking up tiny insects here and there, and now, with a house and an unencumbered basement, the vision of a laboratory shimmered before his eyes. Bug nets appeared and on our continuing

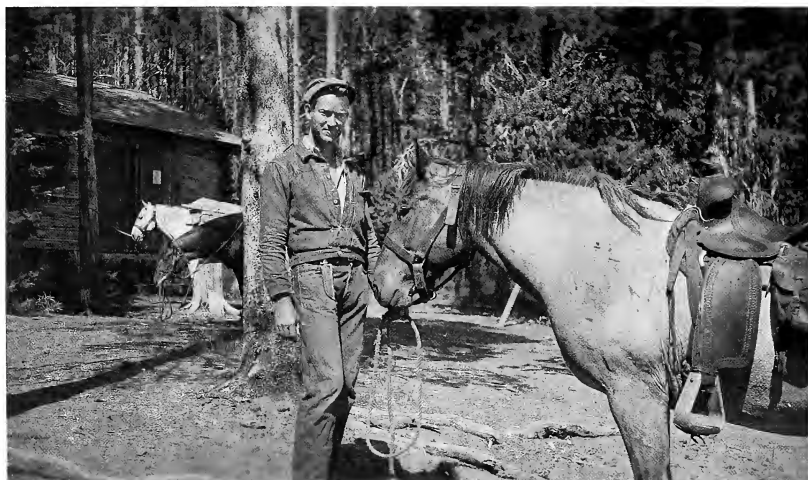


Fig. 4. John T. Polhemus and horse Jim on summer employment in Yellowstone National Park, circa 1953. His experiences in the West as a young man fueled a lifelong love of mountains, fly fishing, and deer hunting, and a lifelong antipathy toward horses. He would subsequently put his practical outdoor skills to use in exploring some of the most remote areas of the planet in search of new and unusual water bugs.

excursions to the mountains, more and more time was spent netting insects and less in netting fish.

1964 was a watershed year. It saw the publication of John's first peer-reviewed research paper "A new species of *Ioscytus* from the Western United States" and, possibly more important, our first collecting trip to Mexico, along with his brother Martin and sister-in-law Jean in a newly acquired VW van. The trip was nominally billed as a "vacation." Martin, however, had originally intended to study entomology before being sidetracked into more lucrative pursuits, and the brothers had a synergistic effect upon each other. John returned convinced that Mexico would prove to be a great center of speciation and began planning what proved to be many years of exploration in Mexico and Central America.

In 1966 the children were considered old enough to be included in foreign adventures. The VW was eventually replaced by a larger and sturdier vehicle, a specially outfitted Ford van. The van has since become legendary, and is still with us (I suspect John will be buried in it), having now logged over 500,000 miles, mostly on land. Every year for at least 10 years we would load up duffle bags of collecting equipment and survival gear and set off on camping trips south of the border for periods varying from 2 weeks to 2 months. Our sons soon felt at ease in this fascinating world. They ate strange foods ("If it looks like a gourd it tastes like a gourd"), learned to sleep in hammocks, climbed pyramids and played on so many remote beaches they felt outraged if they had to share one with another Anglo. They also learned to collect bugs. Those were special years and my recollections include playing in the ocean; scrambling up overgrown ruins to share a drink at sunset; camping in the middle of a blackwater stream called Stain Creek in Guatemala,

where we listened, scarcely breathing, as the town crazy lady circled the van in the night, turning the propane gas bottle on and off and scratching on the windows; and sharing John's horror as we watched our 6 year old son John run proudly up to us with a freshly captured coral snake, holding it properly, of course, by the back of its head.

By now the collection, augmented by additional camping and collecting all over the western United States, was taking on world importance. His scientific publications were proliferating and it became apparent to John that he needed a supplemental degree to validate his expertise. In 1977 he received his Ph.D. in Biology from the University of Colorado under the dedicated and inspired supervision of Hobart Smith. This year also saw the first of 6 grants from the National Geographic Society, focused on the study of the zoogeography of the Southern Hemisphere, which ultimately helped to fund collecting trips to New Zealand, New Guinea, Australia, the Malay Archipelago, Southeast Asia, Madagascar and South America. The first of these grants was made in conjunction with Martin Polhemus, the five following grants with our older son, Dan who by 1984 had completed his own Ph.D. in biology. The father-son combination was the fortunate recipient of National Science Foundation grants in 1991 and 1996, which allowed them to investigate the fascinating island of New Guinea in greater detail.

During this time John's work with Martin-Marietta had proceeded without interruption. These were the glory years of the space program and John had the good fortune to be involved with a number of NASA programs, including Apollo. Several patents evolved from his research including a rocking motion sensor for the blind, and non-invasive pulse and blood pressure monitoring devices developed in the early days of the Space Shuttle. Following the completion of his Ph.D. program, NASA put his newly visible skills to use with multidisciplinary contracts to study the applicability of remote sensing to earth biological problems, which required, to his delight, trips to Africa, including the deepest Sahara, to consider control of t'setse flies and desert locusts. Also, during this period, John became involved with the IEEE Computer Society, helping to set up and host the still ongoing Computer Elements Workshop in Vail, Colorado, a project which involves the entire family in its yearly planning and presentation, and whose success is attested to by the continued enthusiastic support and participation of leading professionals in the field over a span of thirty years.

Engineering research was fascinating, but not as fascinating as the world of exploration and insects. In 1985, after 25 years with Martin-Marietta, John opted to take early retirement. A new Denver firm, Computer Technology Associates, set up by old friends and colleagues, temporarily lured him to join them as Chief Engineer, but by now his list of entomological books and papers, produced even on a part time basis, numbered over 100. The collection of water bugs was the most complete in the world and the focus of research for visiting scientists from many countries. After 2 years John made a permanent break with the world of engineering to devote himself to his true obsession, ENTOMOLOGY.

It would be difficult for me to list the honors, adventures and accomplishments of the last 40 years. Positions currently held include: Research Associate at the University of Colorado, Boulder; Adjunct Faculty at Colorado State University, Ft. Collins; Research Associate, American Museum of Natural History, New York;

Research Associate, Smithsonian Institution, Washington, DC; Research Associate, California Academy of Sciences, San Francisco; Research Associate, Bishop Museum, Honolulu; Research Associate, Florida Arthropod Collections, Gainesville; and Adjunct Faculty, University of Southern Illinois, Carbondale.

The collection now numbers over half a million specimens representing 5,000 species. Publications number over 200, many produced in proud conjunction with his older son Dan. John's Heteroptera library of 2,000 volumes, including many rare books, plus 16,000 papers, is the finest in private hands. In 1993 the Smithsonian Institution arranged to purchase the aquatic Heteroptera collection as it existed at that time, with the understanding that it will stay in the family laboratory until John no longer requires it for research. The field work which created this staggering accomplishment has taken John to 67 countries and every continent except Antarctica.

As significant as his professional achievements have been, I believe, if you asked John what had been the most important thing in his life he would answer, without hesitation, his family. Colleagues have expressed envy that John has a son following in his footsteps in the world of entomology. What they do not realize is that he is twice blessed. His second son is following in his earlier footsteps of cutting-edge research as a Mechanical Engineer, at, of all places, Martin-Marietta (now Lockheed-Martin)! His pride in both is beyond expression. In addition we claim two wonderful daughters-in-law (this is not required hyperbole, it is honest feeling) and three talented and energetic grandchildren. "The Family" as they jokingly refer to themselves, is a tight, supportive group. You get one of us, you get us all!

How would I sum up the 48 years in John's company? I guess it could be best expressed by the old Bob Hope theme song:

*Thanks for the memories,
Moonlight on the shore,
Nights in Singapore,
It may have been a headache but it never was a bore,
So thank you so much.*

THE YEARS WITH DAD

JOHN M. POLHEMUS

6499 S. Kline Ct., Littleton, Colorado 80127

My father is John Polhemus, and I share his name. He is at once one of the most intelligent, productive and difficult people I have ever known. I would not wish him to be any other way. I am very much like my father. I believe in hard work, quality of life and excellence. I learned these values largely because of his efforts to make sure I understood their importance.

The following is a list of thoughts and ideas that typify my father as I know him. Most of these items are lessons he has lovingly imparted to me over the years. A few of them are simply ideas that I know he believes to be true.

Do the job right, or don't do it at all.

Saying you'll try is saying you're not going to do it at all; simply say you can.

Never say can't.

Be the best at what you do.

If you start it, finish it.

If you are productive, you will still have a job tomorrow.

Never spend your principal.

Life is not always fair.

Entomology and electrical engineering do go together (really!).

Take care of the land.

If you walk carefully and quietly, you will see more and damage less.

Shortcuts, however tempting, are bad science.

If you kill it, you eat it.

Things usually go on sale at double the price and a third off.

Trust in your father.

Don't trust anybody, not even your father.

Never throw anything away unless it's poisonous or on fire.

If it doesn't make sense, it's probably true.

There is no such thing as a free lunch.

Just because they say it's dangerous doesn't mean we shouldn't go there.

Family is the most important institution of all.

Seek out John Polhemus, and it is anyone's guess whether you will catch him with a collecting net, a fly rod, a hunting rifle or a bag of freshly harvested wild mushrooms in his hand (or possibly a combination of these). He is a man who has a passion for all things in nature, the things he holds most dear. If asked, he would undoubtedly reply that he prefers natural monuments to manmade ones, a tent to a hotel room and a tidal pool to a swimming pool. Rather than a set of golf clubs in his trunk you will find an aspirator, ethanol, nets, etc.

Standing in a Montana river, I watch as he casts 60 feet of fly line and delicately places a #20 caddis fly on the surface of the water next to the opposite bank. A fish

raises to the fly, but rolls away at the last moment. "See there!" he says, "that's how it's been all evening." Out into the stream he goes, scooping up for closer inspection the small flies that dot the water. Soon, he is sitting in his camp, carefully tying flies with the proper structure and coloration. The next evening I witness the harvest of some of the most beautiful rainbow trout the state of Montana has to offer. Entomology at work in sport.

I am a mechanical engineer by trade, not an entomologist. As such, my perceptions of my father's work take on a decidedly different caste from those of my brother and his fellow scientists. I have looked on with fascination during my entire life as he has pored over countless streams, springs and marshes in search of a quarry that I understand little about. I do, however, understand the importance of his work and the efforts of those like him. In a world filled with those that put profit above the planet, men like John Polhemus stand out like a sore thumb. While his fellow engineers at the Martin Marietta corporation slaved to achieve middle management status, he spent three grueling years legitimizing an already well established career in bio-engineering through the pursuit of a doctoral degree at the University of Colorado. Even then, few seemed to take the venture seriously until it became painfully obvious that remote sensing data from orbital platforms had far reaching implications in the management of serious problems such as the control of tsetse fly and screw worm, and that somebody with a background in biology and engineering was needed to make those efforts a success. Entomology at work in engineering. Touché.

"I'm going to be gone for about a week, and I need you to observe these live specimens while I'm gone. All you have to do is count the number of shed casings in each petri dish and verify that the specimen is still alive. Record the data in this book, okay?" With that, he was off to Houston, Texas or somewhere similar to meet with a NASA customer, leaving the small creatures in my charge. I was responsible. I was culpable. I suddenly wasn't sure that I was up to the rigors of scientific research. Having no choice, I rose to the occasion and performed my duties as instructed. Entomology at work in parenting. Hmm.

Recently, my wife Martha and I backpacked into a remote region in the Southeast corner of Colorado. During our little expedition, we happened upon a beautiful canyon hidden in the grasslands. As we sat in a stand of trees next to a small spring, I began to examine the selection of aquatic insects resident to the small pool and thought it a shame that I had no collecting equipment. Certainly I would have to bring my father here to sample the area's potential offerings. I was immediately overcome with the panicky realization that I was actually starting to view the world in entomological terms. I'm not sure how my mother would deal with the thought of her one final family refuge outside of that science being corrupted. No worries.

As I said in the beginning, I am very much like my father. I sought my advanced education late in life, I have a passion for the gifts of nature. I am fascinated by the scientific process, and I have no tolerance for any paradigm that puts money over conservation. If I am quite fortunate, I will someday have the opportunity to contribute to the world scientific community in his same tradition of perseverance and excellence. While there are those that will argue about the nuances of how to conduct research, I think that there will be few that can argue about the contributions that my father has made to science, and to his family. Efforts made not in the pursuit of self recognition, but in the interest of mankind. Thanks, dad.

NAMES PROPOSED AND TAXONOMIC PUBLICATIONS BY
JOHN T. POLHEMUS, 1964-1998

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Abstract.—A list of taxonomic names proposed, with designated holotype repositories, and a bibliography are presented for John T. Polhemus for the years 1964 to 1998 inclusive. Appendices are provided listing names proposed in honor of John T. Polhemus, and explaining holotype repository codons.

TAXA PROPOSED BY JOHN T. POLHEMUS

The list below lists taxa, with proposed names in bold type and current generic placement in brackets, followed by the designated type repository. A list of type repository acronyms is provided in Appendix 2. A notation of "nyd" indicates a type repository has not yet been designated, and that the holotype is still held in the J. T. Polhemus Collection, Englewood, Colorado (JTPC).

CIMICOMORPHA

MIRIDAE

<i>Coquillettia</i> (Procoquillettia) D. Polhemus & J. Polhemus, n. subgen. 1988	N/A
<i>Coquillettia</i> (<i>Procoquillettia</i>) alpina D. Polhemus & J. Polhemus 1988	USNM
Ephedrodoma D. Polhemus & J. Polhemus, n. gen. 1984	N/A
<i>Ephedrodoma</i> multilineata D. Polhemus & J. Polhemus 1984	USNM
Phoradendrepulus D. Polhemus & J. Polhemus, n. gen. 1985	N/A
<i>Phoradendrepulus</i> myrmecomorphus D. Polhemus & J. Polhemus 1985	USNM

GERROMORPHA

GERRIDAE

<i>Amemboa</i> (Amemboides) Polhemus & Andersen, n. subgen. 1984	N/A
<i>Amemboa</i> armata Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> burmensis Polhemus & Andersen 1984	SEMC
<i>Amemboa</i> cristata Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> dentata Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> esakii Polhemus & Andersen 1984	BPBM
<i>Amemboa</i> incurvata Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> lannae Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> nodosa Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> perlata Polhemus & Andersen 1984	ZMUC
<i>Amemboa</i> philippinensis Polhemus & Andersen 1984	BMNH
<i>Amemboa</i> prostata Polhemus & Andersen 1984	BPBM
<i>Amemboa</i> ptychoconnexiva Polhemus & Andersen 1984	BPBM
<i>Amemboa</i> riparia Polhemus & Andersen 1984	ZMUC

<i>Amemboa setosa</i> Polhemus & Andersen 1984	BMNH
<i>Amemboa sexualis</i> Polhemus & Andersen 1984	BPBM
<i>Amemboa speciosa</i> Polhemus & Andersen 1984	BPBM
<i>Amemboa velaris</i> Polhemus & Andersen 1984	ZMUC
<i>Andersenella</i> J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Andersenella binotata</i> J. Polhemus & D. Polhemus 1993	BPBM
<i>Aquarius lili</i> D. Polhemus & J. Polhemus 1994	USNM
<i>Calyptobates</i> J. Polhemus & D. Polhemus, n. gen. 1994	N/A
<i>Calyptobates amboina</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Calyptobates andaman</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Calyptobates jourama</i> J. Polhemus & D. Polhemus 1994	ANIC
<i>Calyptobates minimus</i> J. Polhemus & D. Polhemus 1994	ANIC
<i>Calyptobates rubidus</i> J. Polhemus & D. Polhemus 1994	ANIC
<i>Calyptobates samarinda</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Calyptobates simplex</i> J. Polhemus & D. Polhemus 1994	BPBM
<i>Ciliometra</i> J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Ciliometra femorata</i> J. Polhemus & D. Polhemus 1993	BPBM
<i>Ciliometra kiunga</i> J. Polhemus & D. Polhemus 1993	BPBM
<i>Ciliometra sepik</i> J. Polhemus & D. Polhemus 1993	USNM
<i>Cryptobates johorensis</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Cryptobates rufus</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Cryptobatoides</i> Polhemus, n. gen. 1991	N/A
<i>Cryptobatoides brunneus</i> Polhemus 1991	INPA
<i>Gnomobates</i> J. Polhemus & D. Polhemus, n. gen. 1995	N/A
<i>Halobates acherontis</i> Polhemus 1982	ANIC
<i>Halobates herringi</i> Polhemus & Cheng 1982	ANIC
<i>Halobates murphyi</i> J. Polhemus & D. Polhemus 1991	BPBM
<i>Hynesionella karatara</i> Polhemus 1998	USNM
<i>Hynesionella slateri</i> Polhemus 1998	AMNH
<i>Iobates</i> J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Iobates salawati</i> J. Polhemus & D. Polhemus 1993	USNM
<i>Iobates somare</i> J. Polhemus & D. Polhemus 1993	BPBM
<i>Limnometra grallator</i> D. Polhemus & J. Polhemus 1998	BPBM
<i>Metrobatini</i> J. Polhemus & D. Polhemus, n. tribe 1993	N/A
<i>Metrobatoides</i> J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Metrobatoides genitalis</i> J. Polhemus & D. Polhemus 1993	BPBM
<i>Metrobatopsis browni</i> J. Polhemus & D. Polhemus 1993	BMNH
<i>Metrobatopsis insularis</i> J. Polhemus & D. Polhemus 1993	USNM
<i>Metrobatopsis lannae</i> J. Polhemus & D. Polhemus 1993	ZMUC
<i>Metrobatopsis mussau</i> J. Polhemus & D. Polhemus 1993	ZMUC
<i>Naboandelini</i> J. Polhemus & D. Polhemus, n. tribe 1993	N/A
<i>Naboandelus borneensis</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Naboandelus johorensis</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Naboandelus taprobanicus</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Onychotrechus singalensis</i> Polhemus & Andersen 1984	USNM
<i>Potamobates anchicaya</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Potamobates carvalhoi</i> J. Polhemus & D. Polhemus 1995	USNM

<i>Potamobates</i> manzanoae J. Polhemus & D. Polhemus 1995	USNM
<i>Potamobates</i> spiculus J. Polhemus & D. Polhemus 1983	USNM
<i>Potamometropsis</i> bruneiensis Polhemus & Zettel 1997	NMSC
<i>Potamometropsis</i> crassifemur Polhemus & Zettel 1997	NHMW
<i>Potamometropsis</i> kundesana Polhemus & Zettel 1997	USNM
<i>Potamometropsis</i> poring Polhemus & Zettel 1997	USNM
<i>Potamometropsis</i> sabah Polhemus & Zettel 1997	USNM
Pseudohalobates J. Polhemus & D. Polhemus, n. gen. 1996	N/A
<i>Pseudohalobates</i> inobonto J. Polhemus & D. Polhemus 1996	USNM
<i>Rhagadotarsus</i> anomalus Polhemus & Karunaratne 1993	ANIC
<i>Rhagadotarsus</i> borneensis Polhemus & Karunaratne 1993	USNM
<i>Rhagadotarsus</i> taprobanicus Polhemus & Karunaratne 1993	USNM
<i>Rheumatobates</i> aestuarius Polhemus 1969	USNM
<i>Rheumatobates</i> longisetosus Polhemus & Manzano 1992	USNM
<i>Rheumatobates</i> ornatus Polhemus & Cheng 1976	USNM
<i>Rheumatobates</i> peculiaris Polhemus & Spangler 1989	USNM
<i>Rheumatobates</i> proholicornis Polhemus & Manzano 1992	USNM
<i>Rheumatobates</i> prostatus Polhemus 1975	USNM
<i>Rheumatometroides</i> insularis papar J. Polhemus & D. Polhemus 1996	USNM
<i>Rheumatometroides</i> kikori J. Polhemus & D. Polhemus 1996	BPBM
<i>Rheumatometroides</i> sele J. Polhemus & D. Polhemus 1996	USNM
<i>Rheumatometroides</i> wabon J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> australicus J. Polhemus & D. Polhemus 1991	ANIC
<i>Stenobates</i> carpentaria J. Polhemus & D. Polhemus 1991 [<i>Rheumatometroides</i>]	USNM
<i>Stenobates</i> fakfak J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> insularis Polhemus & Cheng 1982 [<i>Rheumatometroides</i>]	USNM
<i>Stenobates</i> kamojo J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> kasim J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> labuha J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> langoban J. Polhemus & D. Polhemus 1996	USNM
<i>Stenobates</i> sangihe J. Polhemus & D. Polhemus 1996	RMNH
<i>Stenobates</i> zamboanga J. Polhemus & D. Polhemus 1996	USNM
Stenobatini J. Polhemus & D. Polhemus, n. tribe 1993	N/A
Stenobatopsis J. Polhemus & D. Polhemus, n. gen. 1996	N/A
<i>Stenobatopsis</i> stygius J. Polhemus & D. Polhemus 1996	USNM
Stygiobates J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Stygiobates</i> iriana J. Polhemus & D. Polhemus 1993	USNM
<i>Stygiobates</i> morotai J. Polhemus & D. Polhemus 1993	USNM
Telmatometroides Polhemus, n. gen. 1991	N/A
Thetibates J. Polhemus & D. Polhemus, n. gen. 1996	N/A

HEBRIDAE

<i>Hebrus buenoi</i> furvus Polhemus & Chapman 1970	USNM
<i>Hebrus</i> linnavuorii Polhemus 1989 (n. n. for <i>H. obscurus</i> Cobben)	N/A
<i>Hebrus</i> longivillus Polhemus & McKinnon 1983	USNM

<i>Hebrus mangrovensis</i> J. Polhemus & D. Polhemus 1989	USNM
<i>Hebrus nereis</i> J. Polhemus & D. Polhemus 1989	USNM
<i>Hebrus obscura</i> Polhemus & Chapman 1966	USNM
<i>Hebrus pilosidorsus</i> Polhemus & Chapman 1970	AMNH
<i>Hebrus spiculus</i> Polhemus & McKinnon 1983	USNM
<i>Stenohebrus</i> Polhemus, n. gen. 1995 †(Fossil)	N/A
<i>Stenohebrus glaesarius</i> Polhemus 1995 †(Fossil)	UCPM

HYDROMETRIDAE

<i>Hydrometra carinata</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra cavernicola</i> J. Polhemus & D. Polhemus 1987	USNM
<i>Hydrometra claudie</i> Polhemus & Lansbury 1997	ANIC
<i>Hydrometra cracens</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra darwiniana</i> Polhemus & Lansbury 1997	ANIC
<i>Hydrometra eioana</i> Polhemus & Lansbury 1997	BPBM
<i>Hydrometra gagnei</i> J. Polhemus & D. Polhemus 1995	BPBM
<i>Hydrometra gilloglyi</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra jourama</i> Polhemus & Lansbury 1997	ANIC
<i>Hydrometra julienoidea</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra kelantan</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra kiunga</i> Polhemus & Lansbury 1997	BPBM
<i>Hydrometra lombok</i> J. Polhemus & D. Polhemus 1995	USNM
<i>Hydrometra mindoroensis</i> Polhemus 1976	CAS
<i>Hydrometra novaehollandiae</i> Polhemus & Lansbury 1997	ANIC
<i>Hydrometra phytophila</i> J. Polhemus & D. Polhemus 1987	USNM
<i>Hydrometra seychellensis</i> J. Polhemus & D. Polhemus 1995	USNM

MESOVELIIDAE

<i>Cavaticovelgia</i> Andersen & Polhemus, n. gen. 1980	N/A
<i>Cryptovelgia</i> Andersen & Polhemus, n. gen. 1980	N/A
<i>Cryptovelgia terrestris</i> Andersen & Polhemus 1980	QBUM
<i>Darwinivelgia</i> Andersen & Polhemus, n. gen. 1980	N/A
<i>Darwinivelgia angulata</i> Polhemus & Manzano 1992	USNM
<i>Darwinivelgia fosteri</i> Andersen & Polhemus 1980	BMNH
<i>Mesovelgia halirrhyta</i> Polhemus 1975	USNM
<i>Mniovelgia</i> Andersen & Polhemus, n. gen. 1980	N/A
<i>Mniovelgia kuscheli</i> Andersen & Polhemus 1980	DSIR
<i>Nereivelgia</i> J. Polhemus & D. Polhemus, n. gen. 1989	N/A
<i>Nereivelgia murphyi</i> J. Polhemus & D. Polhemus 1989	USNM
<i>Speovelgia mexicana</i> Polhemus 1975	CAS

VELIIDAE

<i>Aegilipsicola</i> J. Polhemus & D. Polhemus, n. gen. 1994	N/A
<i>Aegilipsicola rapida</i> J. Polhemus & D. Polhemus 1994	BPBM
<i>Aegilipsovelgia</i> Polhemus, n. gen. 1970	N/A

<i>Aegilipsovelia libasa</i> Polhemus 1970	UCMC
<i>Aegilipsovelia origami</i> Polhemus 1970	UCMC
Aphrovelia J. Polhemus & D. Polhemus, n. gen. 1988	N/A
<i>Aphrovelia phoretica</i> J. Polhemus & D. Polhemus 1988	USNM
Cylicovelie Polhemus & Copeland, n. gen. 1996	N/A
<i>Cylicovelie kenyana</i> Polhemus & Copeland 1996	NMKE
<i>Euvelia concava</i> J. Polhemus & D. Polhemus 1984	CAS
<i>Euvelia discala</i> J. Polhemus & D. Polhemus 1984	ZSMC
<i>Euvelia lata</i> J. Polhemus & D. Polhemus 1984	ZSMC
<i>Halovelie (Colpovelie)</i> Polhemus, n. subgen. 1982	N/A
<i>Halovelie (Colpovelie) angulana</i> Polhemus 1982	ANIC
<i>Microvelie ashlocki</i> Polhemus 1968	CAS
<i>Microvelie cavernula</i> Polhemus 1972	MHNG
<i>Microvelie chanita</i> Polhemus & Hogue 1972	LACM
<i>Microvelie depressa</i> Polhemus 1974	USNM
<i>Microvelie glabrosulcata</i> Polhemus 1974	USNM
<i>Microvelie inquilina</i> Polhemus & Hogue 1972	LACM
<i>Microvelie laevipleura</i> Polhemus 1974	USNM
<i>Microvelie leucothea</i> Polhemus & Manzano 1992	USNM
<i>Microvelie paura</i> Polhemus 1974	USNM
<i>Microvelie pererai</i> Polhemus 1979	USNM
<i>Microvelie psilonota</i> Polhemus 1974	USNM
<i>Microvelie reflexa</i> Polhemus 1974	USNM
<i>Microvelie starmuehlneri</i> Polhemus & Herring 1970	USNM
Neusterensifer J. Polhemus & D. Polhemus, n. gen. 1994	N/A
<i>Neusterensifer compacta</i> J. Polhemus & D. Polhemus 1994	BPBM
<i>Neusterensifer cyclops</i> J. Polhemus & D. Polhemus 1994	BPBM
<i>Neusterensifer gladius</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Neusterensifer nabire</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Neusterensifer sepik</i> J. Polhemus & D. Polhemus 1994	BPBM
<i>Paravelia bullialata</i> J. Polhemus & D. Polhemus 1984	RMNH
<i>Paravelia cupariana</i> J. Polhemus & D. Polhemus 1984	ZSMC
<i>Paravelia dilatata</i> J. Polhemus & D. Polhemus 1984	RMNH
<i>Paravelia foveata</i> J. Polhemus & D. Polhemus 1984	ZSMC
<i>Paravelia juruana</i> J. Polhemus & D. Polhemus 1984	SEMC
<i>Paravelia manausana</i> J. Polhemus & D. Polhemus 1984	ZSMC
<i>Paravelia maritima</i> Polhemus & Manzano 1992 [<i>Platyvelia</i>]	nyd
<i>Paravelia paolettii</i> J. Polhemus & D. Polhemus 1991	nyd
<i>Paravelia spinifera</i> J. Polhemus & D. Polhemus 1984	RMNH
<i>Paravelia stenoptera</i> J. Polhemus & D. Polhemus 1984	RMNH
<i>Paravelia truxali</i> J. Polhemus & D. Polhemus 1985	LACM
Platyvelia J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Pseudovelie gnoma</i> Polhemus 1979	nyd
<i>Pseudovelie reiseni</i> Polhemus 1976	USNM
<i>Rhagovelie aestiva</i> Polhemus 1980	AMNH
<i>Rhagovelie agilis</i> Polhemus 1976	USNM
<i>Rhagovelie akrita</i> Polhemus 1976	USNM

<i>Rhagovelia</i> andaman Polhemus 1990	USNM
<i>Rhagovelia</i> atrispina Polhemus 1977	USNM
<i>Rhagovelia</i> bacanensis J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> borneensis J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> celebensis J. Polhemus & D. Polhemus 1989	BMNH
<i>Rhagovelia</i> chiapensis Polhemus 1980	USNM
<i>Rhagovelia</i> christenseni J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> greyi J. Polhemus & D. Polhemus 1989	BMNH
<i>Rhagovelia</i> hamdjahi J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> incognita J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> karunaratnei Polhemus 1979	USNM
<i>Rhagovelia</i> loreinduana J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> meikdelyi J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> melanopsis J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> minahasa J. Polhemus & D. Polhemus 1989	BMNH
<i>Rhagovelia</i> obi J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> pidaxa Polhemus & Herring 1970	USNM
<i>Rhagovelia</i> poissoni Polhemus 1992 (n. n. for <i>R. reitteri femoralis</i> Poisson)	N/A
<i>Rhagovelia</i> pruinosa J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> ranau J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> rivulosa J. Polhemus & D. Polhemus 1985	USNM
<i>Rhagovelia</i> sabela J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> samardaca J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> samarinda J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> sarawakensis J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> silau J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> simulata J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> sondaica J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> starmeuhlneri Polhemus 1990	USNM
<i>Rhagovelia</i> sulawesiana J. Polhemus & D. Polhemus 1989	USNM
<i>Rhagovelia</i> tawau J. Polhemus & D. Polhemus 1989	BPBM
<i>Rhagovelia</i> tebakang J. Polhemus & D. Polhemus 1989	nyd
<i>Rhagovelia</i> unica J. Polhemus & D. Polhemus 1989	nyd
<i>Rhagovelia</i> wallacei J. Polhemus & D. Polhemus 1989	BMNH
Steinovelina J. Polhemus & D. Polhemus, n. gen. 1993	N/A
<i>Stridulivelia</i> (Aenictovelina) Polhemus, n. subgen. 1979	N/A
<i>Stridulivelia</i> (<i>Aenictovelina</i>) secerna Polhemus 1979	USNM
<i>Stridulivelia</i> (<i>Aenictovelina</i>) speciosa J. Polhemus & D. Polhemus 1985	USNM
<i>Stridulivelia</i> (<i>Stridulivelia</i>) anta Polhemus & Spangler 1995	INPA
<i>Stridulivelia</i> (<i>Stridulivelia</i>) ayacucho Polhemus & Spangler 1995	USNM
Tanyvelia J. Polhemus & D. Polhemus, n. gen. 1994	N/A
<i>Tanyvelia</i> missim J. Polhemus & D. Polhemus 1994	BPBM
Tarsovelia J. Polhemus & D. Polhemus, n. gen. 1994	N/A
<i>Tarsovelia</i> alta J. Polhemus & D. Polhemus 1994	BPBM
<i>Tarsovelia</i> arfak J. Polhemus & D. Polhemus 1994	USNM
<i>Tarsovelia</i> dani J. Polhemus & D. Polhemus 1994	USNM

<i>Tetraripis</i> asymmetricus Polhemus & Karunaratne 1979	USNM
<i>Trochopus</i> arcuatus Polhemus & Manzano 1992 [<i>Rhagovelia</i>]	USNM
<i>Trochopus</i> colombianus Polhemus & Manzano 1992 [<i>Rhagovelia</i>]	USNM
<i>Velia</i> atra Polhemus 1968 [<i>Paravelia</i>]	AMNH
<i>Xiphovelia</i> iota Polhemus 1979	USNM

LEPTOPODOMORPHA

LEPTOPODIDAE

<i>Erianotoides</i> J. Polhemus & D. Polhemus, n. gen. 1991	N/A
<i>Erianotoides</i> oculatus J. Polhemus & D. Polhemus 1991	USNM
<i>Leotichius</i> shiva Polhemus & Schuh 1995	AMNH
<i>Leptopoides</i> J. Polhemus & D. Polhemus, n. gen. 1991	N/A
<i>Leptopoides</i> poissoni J. Polhemus & D. Polhemus 1991	USNM
<i>Saldolepta</i> Schuh & J. Polhemus, n. gen. 1980	N/A
<i>Saldolepta</i> kistnerorum Schuh & Polhemus 1980	AMNH
<i>Valleriola</i> kenyana Polhemus 1981	nyd
<i>Valleriola</i> novacaledonica J. Polhemus & D. Polhemus 1987	USNM
<i>Valleriola</i> tribulosa J. Polhemus & D. Polhemus 1987	ANIC
<i>Valleriola</i> tuberculata J. Polhemus & D. Polhemus 1987	BPBM

SALDIDAE

<i>Capitonisalda</i> Polhemus, n. gen. 1981	N/A
<i>Capitonisaldoida</i> J. Polhemus & D. Polhemus, n. gen. 1991	N/A
<i>Capitonisaldoida</i> cryptica J. Polhemus & D. Polhemus 1991	USNM
<i>Enalosalda</i> Polhemus, n. gen. <i>In</i> : Polhemus & Evans 1969	N/A
<i>Ioscytus</i> chapmani McKinnon & Polhemus 1986	USNM
<i>Ioscytus</i> cobbeni Polhemus 1964	USNM
<i>Mascarenisalda</i> J. Polhemus & D. Polhemus, n. gen. 1991	N/A
<i>Paralosalda</i> Polhemus & Evans, n. gen. 1969	N/A
<i>Paralosalda</i> innova Polhemus & Evans 1969	CAS
<i>Pentacora</i> ouachita Polhemus 1994	USNM
<i>Propentacora</i> Polhemus, n. gen. 1985 †(Fossil)	N/A
<i>Rupisalda</i> Polhemus, n. gen. 1985	N/A
<i>Rupisalda</i> atra J. Polhemus & D. Polhemus 1991	USNM
<i>Rupisalda</i> cremnosa Polhemus 1985	USNM
<i>Rupisalda</i> monticola Polhemus 1985	nyd
<i>Rupisalda</i> petricola Polhemus 1985	USNM
<i>Rupisalda</i> slateri J. Polhemus & D. Polhemus 1991	USNM
<i>Rupisalda</i> speciosa Polhemus 1981	nyd
<i>Rupisalda</i> thika Polhemus 1981	USNM
<i>Rupisalda</i> vincenti J. Polhemus & D. Polhemus 1991	USNM
<i>Salda</i> alta Polhemus 1967	USNM
<i>Salda</i> coloradensis Polhemus 1967	USNM
<i>Saldula</i> durangoana Polhemus 1972	USNM
<i>Saldula</i> galapagosana Polhemus 1968	CAS

<i>Saldula</i> lattini Chapman & Polhemus 1965	USNM
<i>Saldula</i> lomata Polhemus 1985	USNM
<i>Saldula</i> luteola Lindskog & Polhemus 1992	NHRS
<i>Saldula</i> montana Cobben & Polhemus 1966	SEMC
<i>Saldula</i> saxicola Polhemus 1972 [<i>Rupisalda</i>]	USNM
<i>Saldula</i> usingeri Polhemus 1967	CAS
<i>Saldula</i> waltoni Cobben & Polhemus 1966 [<i>Rupisalda</i>]	SEMC
<i>Saldula</i> zena Polhemus 1985	USNM
<i>Salduncula</i> fasciata Polhemus 1991	USNM
<i>Salduncula</i> murphyi Polhemus 1991	USNM
<i>Salduncula</i> palawanensis Polhemus 1991	USNM
<i>Saldunculini</i> Polhemus, n. tribe 1985	N/A

NEPOMORPHA

APHELOCHEIRIDAE

<i>Aphelocheirus</i> ashlocki D. Polhemus & J. Polhemus 1989	BPBM
<i>Aphelocheirus</i> baguio D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> (<i>Micraphelocheirus</i>) brevirostris D. & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> cantonensis D. Polhemus & J. Polhemus 1989	nyd
<i>Aphelocheirus</i> celebensis D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> clivicolus Polhemus 1979	nyd
<i>Aphelocheirus</i> dudgeoni D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> fang D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> femoratus D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> grik D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> javanicus D. Polhemus & J. Polhemus 1989	CAS
<i>Aphelocheirus</i> kinabalu D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> lahu D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> lao D. Polhemus & J. Polhemus 1989	BPBM
<i>Aphelocheirus</i> lorelindu D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> luzonicus D. Polhemus & J. Polhemus 1989	SEMC
<i>Aphelocheirus</i> malayanus D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> minor D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> palawanensis D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> petersi D. Polhemus & J. Polhemus 1989	LACM
<i>Aphelocheirus</i> sculpturatus D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> similaris D. Polhemus & J. Polhemus 1989	ZMAS
<i>Aphelocheirus</i> thai D. Polhemus & J. Polhemus 1989	USNM
<i>Aphelocheirus</i> zamboanga D. Polhemus & J. Polhemus 1989	USNM

BELOSTOMATIDAE

<i>Diplonychus</i> heeri Polhemus 1995 (n. n. for <i>D. rotundatus</i> Heer 1853) †(Fossil)	N/A
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CORIXIDAE

<i>Micronecta wroblewskii</i> Polhemus 1979	USNM
<i>Morphocorixa tarahumara</i> Polhemus & Jansson 1987	USNM
<i>Morphocorixa yaqui</i> Jansson & Polhemus 1987	MZHF
<i>Tenagobia (Baliagobia) castanea</i> Polhemus & Nieser 1997	USNM

GELASTOCORIDAE

<i>Nerthra spangleri</i> Polhemus 1972	USNM
<i>Nerthra toddi</i> Polhemus & Linds kog 1994	USNM

HELOTREPHIDAE

<i>Distotrephes</i> Polhemus, n. gen. 1990	N/A
<i>Distotrephes heveli</i> Polhemus 1990	USNM
<i>Distotrephes stysi</i> Polhemus 1990	USNM
<i>Helotrephes affinis</i> Zettel & Polhemus 1998	CNTN
<i>Helotrephes australis</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes flaviceps</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes incisus</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes javanicus</i> Zettel & Polhemus 1998	nyd
<i>Helotrephes kodadai</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes major</i> Zettel & Polhemus 1998	CNTN
<i>Helotrephes nieserianaus</i> Zettel & Polhemus 1998	CNTN
<i>Helotrephes porntipae</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes semiglobosus hainanicus</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes shepardi</i> Zettel & Polhemus 1998	NHMW
<i>Helotrephes tuberculatus</i> Zettel & Polhemus 1998	NHMW
<i>Hydrotrephes celebensis</i> Polhemus 1997	USNM
<i>Hydrotrephes kamarora</i> Polhemus 1997	USNM
<i>Hydrotrephes marana</i> Polhemus 1997	USNM
<i>Hydrotrephes nieseri</i> Polhemus 1997	USNM
<i>Hydrotrephes taweli</i> Polhemus 1997	USNM
<i>Hydrotrephes variegatus</i> Polhemus 1997	USNM
<i>Hydrotrephes viriosus</i> Polhemus 1997	USNM
<i>Limnotrephes kumaonis</i> Polhemus 1990	BMNH
<i>Limnotrephini</i> Polhemus, n. tribe 1990	N/A

NAUCORIDAE

<i>Ambrysus baeus</i> J. Polhemus & D. Polhemus 1982	USNM
<i>Ambrysus colimanus</i> J. Polhemus & D. Polhemus 1982	USNM
<i>Ambrysus plautus</i> J. Polhemus & D. Polhemus 1983	USNM
<i>Ambrysus relictus</i> J. Polhemus & D. Polhemus 1994	USNM
<i>Ambrysus spiculus</i> J. Polhemus & D. Polhemus 1982	USNM
<i>Cavocoris ibatiri</i> D. Polhemus & J. Polhemus 1989	BPBM
<i>Cavocoris ismayi</i> D. Polhemus & J. Polhemus 1989	BPBM

<i>Cavocoris</i> minor D. Polhemus & J. Polhemus 1989	BPBM
<i>Cavocoris</i> rotundatus D. Polhemus & J. Polhemus 1989	BPBM
<i>Idiocarus</i> isolatus D. Polhemus & J. Polhemus 1986	BPBM
<i>Idiocarus</i> papuas D. Polhemus & J. Polhemus 1986	BPBM
<i>Idiocarus</i> sepikanus D. Polhemus & J. Polhemus 1986	BPBM
<i>Naucoris</i> rhizomatus Polhemus 1984	ANIC
<i>Nesocricus</i> kukukuku D. Polhemus & J. Polhemus 1985	BPBM
<i>Nesocricus</i> montanus D. Polhemus & J. Polhemus 1985	BPBM
Philippinocoris D. Polhemus & J. Polhemus, n. gen. 1987	N/A
Procryphocricus Polhemus, n. gen. 1991	N/A
<i>Procryphocricus</i> perplexus Polhemus 1991	nyd
<i>Tanyricus</i> froeschneri D. Polhemus & J. Polhemus 1986	BPBM

NEPIDAE

<i>Ranatra</i> montezuma Polhemus 1976	USNM
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NOTONECTIDAE

<i>Notonecta</i> hungerfordi Polhemus 1993 (n. n. for <i>N. minuta</i> Hungerford 1926)	N/A
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OCHTERIDAE

<i>Ochterus</i> rotundus J. Polhemus & M. Polhemus 1976	USNM
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LIFE SCIENCES PUBLICATIONS OF JOHN T. POLHEMUS

1. 1964 A new species of *Ioscytus* from the Western United States (Hemiptera: Saldidae). Proc. Entomol. Soc. Wash. 66:253-255.
2. 1965 A new shore Bug from Oregon (Hemiptera: Saldidae). J. Kansas Entomol. Soc. 38:359-361. (Co-author; H. C. Chapman, senior author).
3. 1966 Some Hemiptera new to the United States. Proc. Entomol. Soc. Wash. 68:57.
4. 1966 African Saldidae in the Snow Entomological Museum (Hemiptera). J. Kansas Entomol. Soc. 39:382-396. (Co-author; R. H. Cobben, senior author).
5. 1966 Notes on some Hebridae from the United States with the description of a new species (Hemiptera). Proc. Entomol. Soc. Wash. 68:209-211. (Co-author; H. C. Chapman, junior author).
6. 1967 Notes on North American Saldidae (Hemiptera). Proc. Entomol. Soc. Wash. 69:24-30.
7. 1967 A new saldid from California (Hemiptera: Saldidae). Proc. Entomol. Soc. Wash. 69:346-348.
8. 1968 A report on the Saldidae collected by the Galapagos International Scientific Project 1964 (Hemiptera). Proc. Entomol. Soc. Wash. 70:21-24.
9. 1968 A new *Microvelia* from the Galapagos (Hemiptera: Veliidae). Proc. Entomol. Soc. Wash. 70:129-132.
10. 1969 A new *Velia* from Peru, and the description of the male of *Velia he-*

- lenae* Hungerford (Hemiptera: Veliidae). Proc. Entomol. Soc. Wash. 71:55–58.
11. 1969 Lectotype designations for some Saldidae (Hemiptera) described by P. R. Uhler. Ann. Entomol. Soc. Amer. 62(5):1207–1208.
 12. 1969 A new *Rheumatobates* from Mexico (Hemiptera: Gerridae). J. Kans. Entomol. Soc. 42(4):509–511.
 13. 1969 A new genus of intertidal Saldidae from the Eastern Tropical Pacific with notes on its biology (Hemiptera). Pacific Insects 11(3):57–64. (Co-author; W. G. Evans, junior author).
 14. 1970 Some notes concerning American Hebridae, with the descriptions of a new species and subspecies (Hemiptera). Proc. Entomol. Soc. Wash. 72(1):51–54. (Co-author; H. C. Chapman, junior author).
 15. 1970 Ergebnisse der Österreichischen Neukaledonien Expedition. Aquatic and semi-aquatic Hemiptera. Proc. Entomol. Soc. Wash. 72(2):179–187. (Co-author; J. L. Herring, junior author).
 16. 1970 A new genus of Veliidae from Mexico (Hemiptera). Proc. Entomol. Soc. Wash. 72(4):443–448.
 17. 1970 Etudes Hydrobiologiques en Nouvelle-Calédonie (Mission 1965 du Premier Institut de Zoologie de l'Université de Vienne) (Suite). Cah. O.R.S.T.O.M., ser Hydrobiol. 4(2):3–12. (Co-author; J. L. Herring, junior author).
 18. 1972 Two new *Microvelia* from crabholes in Costa Rica (Veliidae: Hemiptera). Contrib. Sci., Los Angeles Co. Mus. 224:1–6. (Co-author; C. L. Hogue, junior author).
 19. 1972 Notes on veliids from Venezuela, with the description of a new *Microvelia*. Rev. Suisse Zool. 79(2):903–905.
 20. 1972 Notes concerning Mexican Saldidae, including the description of two new species (Hemiptera). Great Basin Natur. 32(3):137–153.
 21. 1972 Notes on the genus *Nerthra*, including the description of a new species (Hemiptera, Gelastocoridae). Proc. Entomol. Soc. Wash. 74(3):306–309.
 22. 1973 Notes on aquatic and semi-aquatic Hemiptera from the southwestern United States (Insecta: Hemiptera). Great Basin Natur. 33(2):113–119.
 23. 1973 Lectotype designation for *Gerris buenoi* Kirkaldy (Heteroptera: Gerridae). Pan.-Pac. Entomol. 49(3):257. (Co-author; A. S. Menke, senior author).
 24. 1973 The occurrence of *Trichochorixa reticulata* in the Gulf of California (Hemiptera: Corixidae). Pan.-Pac. Entomol. 50(1):52. (Co-author; J. R. Hendrickson, junior author).
 25. 1974 The *austrina* group of the genus *Microvelia* (Hemiptera: Veliidae). Great Basin Natur. 34(3):207–217.
 26. 1974 Lipids of the water-strider *Gerris remigis* Say (Heteroptera: Gerridae): Seasonal and developmental variations. Comp. Biochem. Physiol. 518: 451–456. (Co-author; R. F. Lee, senior author, and L. Cheng).
 27. 1975 Lectotype designation for *Hebrus sobrinus* Uhler (Hemiptera, Hebridae). Proc. Entomol. Soc. Wash. 77:128.
 28. 1975 New estuarine and intertidal water striders from Mexico and Costa

- Rica (Hemiptera: Gerridae, Mesoveliidae). Pan-Pac. Entomol. 51(3): 243-247.
29. 1976 Water-striders (Hemiptera: Gerridae, Veliidae, etc.), pp. 187-224 in Cheng, L., Marine Insects. Elsevier, New York. (Co-author; N. M. Andersen, senior author).
 30. 1976 Shore bugs (Hemiptera: Saldidae, etc.) pp. 225-262 in Cheng, L., Marine Insects, Elsevier, New York.
 31. 1976 Notes on North American Nepidae (Hemiptera, Heteroptera). Pan-Pac. Entomol. 52(3):204-208.
 32. 1976 A reconsideration of the status of the genus *Paravelia* Breddin, with other notes and a check-list of species (Veliidae: Heteroptera). J. Kans. Entomol. Soc. 49(4):509-513.
 33. 1976 Aquatic and semi-aquatic Hemiptera of the Grand Canyon. Great Basin Natur. 36(2):221-226. (Co-author; M. S. Polhemus, junior author)
 34. 1977 A new *Rheumatobates* from Costa Rica (Hemiptera: Gerridae). Pan-Pac. Entomol. 52(4):321-323. (Co-author; L. Cheng, junior author).
 35. 1976 Aquatic Hemiptera of the Philippines. KALIKASAN, Philipp. J. Biol. 5(3):259-294. (Co-author; W. K. Reisen, junior author).
 36. 1976 Type designations and other notes concerning Veliidae (Insecta: Hemiptera). Proc. Entomol. Soc. Wash. 79(4):637-648.
 37. 1977 Marine Saldidae (Hemiptera): Important indicators of zoogeography and phylogeny. (Abstract), Annual Meeting of Canadian Society of Zoologists, May 8-11, Victoria, B.C.
 38. 1977 Neotype designation for *Hebrus sobrinus* Uhler (Heteroptera: Hebridae). Proc. Entomol. Soc. Wash. 79(2):237.
 39. 1978 The Veliidae (Heteroptera) of America North of Mexico—keys and check list. Proc. Entomol Soc. Wash. 80(1):56-68. (Co-author; C. L. Smith, senior author).
 40. 1978 The biology and systematics of the Saldidae of Mexico and Middle America, Diss. Abst. Int., 38(5), 2 pp.
 41. 1977 The biology and systematics of the Saldidae of Mexico and Middle America. Ph.D. dissertation, Univ. of Colorado, Boulder, 625 pp.
 42. 1978 Aquatic and semi-aquatic Hemiptera, pp. 119-131 in K. W. Cummins and R. W. Merritt (eds.), An Introduction to the Aquatic Insects of North America. Kendall/Hunt, Dubuque, xiii + 441 pp.
 43. 1979 Saldidae, Ch. 2, pp. 16-33 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author: H.C. Chapman, junior author).
 44. 1979 Hebridae, Ch. 3, pp. 34-38 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).
 45. 1979 Mesoveliidae, Ch. 4, pp. 39-42 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).
 46. 1979 Hydrometridae, Ch. 5, pp. 43-45 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).

47. 1979 Macroveliidae, Ch. 6, pp. 46–48 in A. S. Menke (ed.), The Semi-aquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).
48. 1979 Veliidae, Ch. 7, pp. 49–57 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).
49. 1979 Gerridae, Ch. 8, pp. 58–69 in A. S. Menke (ed.), The Semiaquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv. (Co-author; H. C. Chapman, junior author).
50. 1979 Naucoridae, Ch. 14, pp. 131–138 in A. S. Menke (ed.), The Semi-aquatic and Aquatic Hemiptera of California. Bull. Calif. Ins. Surv.
51. 1979 A new species of *Stridulivelia* from Mexico and a new subgenus from Middle America (Veliidae: Hemiptera). Pan-Pac. Entomol. 55 (1):46–50.
52. 1979 A further description of *Hermatobates bredini* Herring, and a new record for Cuba (Hemiptera: Hermatobatidae). Proc. Entomol. Soc. Wash. 81 (2):253–254. (Co-author; J. L. Herring, junior author).
53. 1980 *Saldolepta kistnerorum*, new genus and new species from Ecuador (Hemiptera, Leptopodomorpha), the sister group of *Leptosalda chiapensis*. Amer. Mus. Novitates 2698:1–5. (Co-author; R. T. Schuh, senior author).
54. 1980 Analysis of taxonomic congruence among morphological, ecological, and biogeographical data sets for the Leptopodomorpha (Hemiptera). Syst. Zool. 29:1–26. (Co-author; R. T. Schuh, senior author).
55. 1980 Studies on Neotropical Veliidae (Hemiptera). V. New species of *Rhagovelia*. Pan-Pac. Entomol. 56(4):311–315.
56. 1980 Four new genera of Mesoveliidae (Hemiptera: Gerromorpha) and the phylogeny and classification of the family. Entomol. Scand. 11:369–392. (Co-author; N. M. Andersen, senior author).
57. 1980 Results of the Austrian-Ceylonese Hydrobiological Mission 1970, of the Institute of Zoology of the University of Vienna (Austria) and the Department of Zoology of the University of Sri Lanka, Vidyalkara Campus, Kelaniya. Part XIX: Aquatic Semiaquatic Hemiptera of Sri Lanka from the Austrian Indo-Pacific Expedition 1970–71. Bull. Fish. Res. Stn., Sri Lanka 29:89–113, 1979.
58. 1981 The phylogeny of the Leptopodomorpha. Rostria 33 Suppl.:17–27.
59. 1981 Three new species of *Ambrysus* from Mexico (Hemiptera: Naucoridae). Pan-Pac. Entomol. 57(3):397–401. (Co-author; D. A. Polhemus, junior author).
60. 1981 African Leptopodomorpha (Hemiptera: Heteroptera): A checklist and descriptions of new taxa. Ann. Natal Mus. 24(2):603–619.
61. 1982 Marine Hemiptera of the Northern Territory, including the first freshwater species of *Halobates* Eschscholtz (Gerridae, Veliidae, Hermatobatidae and Corixidae). J. Austr. Entomol. Soc. 21:5–11.
62. 1982 Hemiptera, pp. 288–327 in Hurlbert, S. H. and A. Villalobos-Figueroa (eds.), Aquatic Biota of Mexico, Central America and the West Indies. San Diego, xv + 529 pp.
63. 1982 Notes on marine water-striders, mainly from the Pacific and Indian

- Oceans, with descriptions of new species. Part I. Gerridae (Hemiptera). Pac. Ins. 24(3-4):219-227. (Co-author; L. Cheng, junior author).
64. 1983 Notes on the Hebridae of the Western Hemisphere with a description of two new species (Heteroptera: Hemiptera). Proc. Entomol. Soc. Wash. 85(1):110-115. (Co-author; C. N. McKinnon, junior author).
 65. 1983 A new species of *Potamobates* from Peru (Hemiptera-Heteroptera: Gerridae). J. Kansas Entomol. Soc. 56(3):286-288. (Co-author; D. A. Polhemus, junior author).
 66. 1983 Notes on Neotropical Naucoridae II. A new species of *Ambrysus* and review of the genus *Potamocoris*. Pan-Pac. Entomol. 58(4):326-329. (Co-author; D. A. Polhemus, junior author).
 67. 1984 Notes on Neotropical Veliidae (Hemiptera) VI. Revision of the genus *Euvelia*. Pan-Pac. Entomol. 60(1):55-62. (Co-author; D. A. Polhemus, junior author).
 68. 1984 Studies on Neotropical Veliidae (Hemiptera) VII. Description of four new species of *Paravelia* Breddin. Amazoniana 8(3):339-349. (Co-author; D. A. Polhemus, junior author).
 69. 1984 A review of the Naucorinae of Australia (Heteroptera: Naucoridae). J. Aust. Entomol. Soc. 23:157-160.
 70. 1984 *Ephedrodroma*, a new genus of orthotyline Miridae (Hemiptera) from western United States. Proc. Entomol. Soc. Wash. 86(3):550-554. (Co-author; D. A. Polhemus, senior author).
 71. 1984 Caeciliidae in Amphibia and Insecta (Psocoptera): Alternative proposals to remove the homonymy. Z.N. (S.) 2333. Bull. Zool. Nom. 41(2): 108-109. (Co-author; H. M. Smith, senior author).
 72. 1984 The phylogeny and zoogeography of New Guinea Gerromorpha (Abstract), p. 887 in XVII Int. Congr. Entomol., Hamburg, Aug. 20-26, 1984, Abstract Vol., 953 pp.
 73. 1984 Aquatic and semiaquatic Hemiptera, pp. 231-260 in R. W. Merritt and K. W. Cummins (eds.), An Introduction to the Aquatic Insects of North America, 2nd edition. Kendall/Hunt, Dubuque, xxiii + 722 pp.
 74. 1984 A revision of *Amemboa* Esaki with notes on the phylogeny and ecological evolution of eotrechine water striders (Insecta, Hemiptera, Gerridae). Steenstrupia 10(3):65-111 (Co-author; N. M. Andersen, junior author).
 75. 1984 Notes on Neotropical Veliidae IX. New species of *Paravelia* from tropical South America. Amazoniana 8:497-504. (Co-author; D. A. Polhemus, junior author).
 76. 1985 Myrmecomorphic Miridae (Hemiptera) from Mistletoe. Pan-Pac. Entomol. 61(1):26-31. (Co-author; D. A. Polhemus, senior author).
 77. 1985 Zoogeography of Saldidae and other aquatic Hemiptera in the Southern Hemisphere. National Geographic Society Research Reports, 1977 Projects. pp. 601-609.
 78. 1985 Notes on Neotropical Veliidae VIII. New Species and notes. Pan-Pac. Entomol. 61(2):163-169. (Co-author; D. A. Polhemus, junior author).
 79. 1985 Shore Bugs (Heteroptera, Hemiptera; Saldidae). A world overview and

- taxonomy of Middle American Forms. The Different Drummer, Englewood, Colorado, v+252 pp.
80. 1985 Naucoridae (Hemiptera) of New Guinea. I. A review of the genus *Nesocricos* (Hemiptera: Naucoridae), with descriptions of two new species. *Int. J. Entomol.* 27(3):197–203. (Co-author; D. A. Polhemus, senior author).
81. 1985 Nomenclatural changes for North American Saldidae. *Proc. Entomol. Soc. Wash.* 87(4):893.
82. 1985 Comments on a water strider, *Rheumatobates meinerti* from the Antilles and a checklist of the species of the genus (Hemiptera: Gerridae). *Entomol. News* 96(5):196–200. (Co-author; P. J. Spangler, senior author, and R. C. Froeschner).
83. 1986 Naucoridae (Hemiptera) of New Guinea. 2. A review of the genus *Idiocarus* Montandon, with descriptions of three new species. *J. New York Entomol. Soc.* 94(1):39–50. (Co-author; D. A. Polhemus, senior author).
84. 1986 The zoogeography and phylogeny of the genus *Ptilomera* Amyot & Serville (Hemiptera: Gerridae). *Bull. N. Amer. Benthological Soc.* 3(2):67. (Abstract) (Co-author; D. A. Polhemus, senior author).
85. 1986 Naucoridae (Heteroptera) of New Guinea. III. A review of the genus *Tanycrios*, with description of a new species. *J. New York Entomol. Soc.* 94(2):163–173. (Co-author; D. A. Polhemus, senior author).
86. 1986 Notes on the genus *Ioscytus* with the description of a new species and a key to species (Hemiptera: Heteroptera; Saldidae). *J. New York Entomol. Soc.* 94(3):434–441. (Co-author; C. N. McKinnon, senior author).
87. 1987 Catalog and bibliography of Leptopodomorpha (Heteroptera). *Bull. American Mus. Natural Hist.* 185(3):243–406. (Co-author; R. T. Schuh, senior author and B. Galil).
88. 1987 The genus *Valleriola* Distant (Hemiptera: Leptopodidae) in Australia, New Caledonia and Papua New Guinea, with notes on zoogeography. *J. Austr. Entomol. Soc.* 26:209–211. (Co-author; D. A. Polhemus, junior author).
89. 1987 A new genus of Naucoridae (Hemiptera) from the Philippines, with notes on zoogeography. *Pan Pac. Entomol.* 63(3):265–269. (Co-author; D. A. Polhemus, senior author).
90. 1987 Revision of the genus *Morphocorixa* Jaczewski (Heteroptera: Corixidae). *Ann. Entomol. Fennici* 53:105–118. (Co-author; A. Jansson, senior author).
91. 1987 Terrestrial Hydrometridae (Heteroptera) from Madagascar, and the remarkable thoracic polymorphism of a closely related species from Southeast Asia. *J. New York Entomol. Soc.* 95(4):509–517. (Co-author; D. A. Polhemus, junior author).
92. 1987 *Microvelia rasilis* Drake in Arizona; a species new to the United States (Heteroptera: Veliidae). *Great Basin Naturalist* 47(4):660. (Co-author; M. W. Sanderson, junior author).
93. 1988 A new ant mimetic mirid from the Colorado tundra (Hemiptera: Mir-

- idae). Pan Pac. Entomol. 64(1):23-27. (Co-author; D. A. Polhemus, senior author).
94. 1988 Zoogeography of the genus *Rhagovelia* in the Malay Archipelago (Hemiptera: Veliidae), Proc. XVIII Int. Congr. Entomol., Vancouver, p. 23. (Abstract) (Co-author; D. A. Polhemus, junior author).
 95. 1988 A new genus of foam inhabiting Veliidae (Heteroptera) from western Madagascar. J. New York Entomol. Soc. 96(3):274-280. (Co-author; D. A. Polhemus, junior author).
 96. 1988 Aquatic and semiaquatic Hemiptera of mangrove cays, coral reefs, lagoons, and estuarine habitats of Stann Creek District, Belize. Bull. North Amer. Benthol. Soc. 5 (1):40. (Abstract) (Co-author; P. J. Spangler, senior author).
 97. 1988 Family Belostomatidae, pp. 47-55 in T. J. Henry & R. C. Froeschner (eds.), Catalog of the Heteroptera of North America, E. J. Brill, New York, xix + 958 pp. (Co-author; D. A. Polhemus and T. J. Henry, junior authors).
 98. 1988 Family Corixidae, pp. 93-118 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; R. C. Froeschner and D. A. Polhemus, junior authors).
 99. 1988 Family Gelastocoridae, pp. 136-139 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; D.A. Polhemus, senior author).
 100. 1988 Family Hebridae, pp. 152-154 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; D. A. Polhemus, junior author).
 101. 1988 Family Naucoridae, pp. 521-527 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; D.A. Polhemus, senior author).
 102. 1988 Family Notonectidae, pp. 533-540 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; D. A. Polhemus, junior author).
 103. 1988 Family Ochteridae, pp. 541-543 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp. (Co-author; D. A. Polhemus, senior author).
 104. 1988 Family Saldidae, pp. 665-681 in T. J. Henry and R. C. Froeschner (eds.), Catalog of the Heteroptera of North America. E. J. Brill, New York, xix + 958 pp.
 105. 1989 Naucoridae (Heteroptera) of New Guinea. IV. A revision of the genus *Cavocoris*, with descriptions of four new species. J. New York Entomol. Soc. 97(1):73-86. (Co-author; D. A. Polhemus, senior author).
 106. 1989 A necessary new name in the family Hebridae (Heteroptera: Gerromorpha). J. New York Entomol. Soc. 97(1):116.
 107. 1989 Zoogeography, ecology, and systematics of the genus *Rhagovelia* (Heteroptera: Veliidae) in Borneo, Celebes, and the Moluccas. Insecta Mundi 2(3-4):161-230. (Co-author; D. A. Polhemus, junior author).
 108. 1989 The Aphelocheirinae of tropical Asia (Heteroptera: Naucoridae). Raf-

- flies Bull. Zool., Singapore, 36(2):167–300. (Co-author; D. A. Polhemus, senior author).
109. 1989 A new species of *Rheumatobates* Bergroth from Ecuador, and distribution of the genus (Hemiptera: Gerridae). Proc. Entomol. Soc. Wash. 91(3):421–428. (Co-author; P. J. Spangler, junior author).
110. 1989 Obituary—Peter D. Ashlock. Pan-Pac. Entomol. 65(3):310–311.
111. 1990 Notes on critical character states in *Telmatotrepes* (Heteroptera: Nepidae). Florida Entomol. 72(4):626–629, 1989. (Co-author; S. L. Keffer, senior author; and J. E. McPherson).
112. 1989 A new mesoveliid genus and two new species of *Hebrus* (Heteroptera: Mesoveliidae, Hebridae) from intertidal habitats in southeast Asian mangrove swamps. Bull. Raffles Mus., Singapore 37(1&2):73–82. (Co-author; D. A. Polhemus, junior author).
113. 1990 Un appareil stridulatoire chez les Leptopodidae de l'Ancein Monde (Heteroptera). Annls. Soc. Entomol. France 26(1):9–17. (Co-author; J. Pericart, senior author).
114. 1990 Obituary; Peter D. Ashlock, with a list of proposed taxa and bibliography. Proc. New York Entomol. Soc. 98(1):113–122. (Co-author; J. A. Slater, senior author).
115. 1990 What is *Nepa hoffmanni* (Heteroptera: Nepidae)? Male genitalia hold the answer, and delimit species groups. J. New York Entomol. Soc. 98(2):154–162. (Co-author; S. L. Keffer, senior author; and J. E. McPherson).
116. 1990 Results of the Austrian-Indian Hydrobiological Mission 1976 to the Andaman-Islands: Part X: List of the aquatic Hemiptera collected in the inland waters of the Andaman Islands. Ann. Naturh. Mus. Wien 91(B):43–51. (Co-author; F. Starmuhlner, junior author).
117. 1990 A new tribe, a new genus and three new species of Helotrephidae (Heteroptera) from southeast Asia, and a world checklist. Acta Entomol. Bohemoslovaca 87:45–63.
118. 1990 Surface wave communication in water striders; field observations of unreported taxa (Gerridae, Veliidae: Heteroptera). J. New York Entomol. Soc. 98(3):383–384.
119. 1989 The Aphelocheirinae of Tropical Asia (Heteroptera: Naucoridae)—Corrigenda and Addenda. Raffles Bull. Zool. 37(1&2):171–172.
120. 1990 Miscellaneous studies on the genus *Rhagovelia* Mayr (Heteroptera: Veliidae) in Southeast Asia and the Seychelles Islands, with keys and descriptions of new species. Raffles Bull. Zool. 38(1):65–75.
121. 1990 Zoogeography of the aquatic Heteroptera of Celebes: regional relationships versus insular endemism, pp. 73–86 in Knight, W. J. and J. D. Holloway (eds.), Insects and the Rain Forests of South East Asia (Wallacea). Roy. Entomol. Soc. Lond., London, iv + 343 pp. (Co-author; D. A. Polhemus, junior author).
122. 1990 Book review—a history of the Hope Entomological Collections in the University Museum, Audrey Z. Smith. Ann. Entomol. Soc. Amer. 83(3):652–653.
123. 1990 Book review—animal evolution in changing environments with special

- reference to abnormal metamorphosis, Ryuichi Matsuda. *Ann. Entomol. Soc. Amer.* 83(3):654.
124. 1991 Two new Neotropical genera of Trepobatinae (Gerridae: Heteroptera). *J. New York Entomol. Soc.* 99(1):78-86.
125. 1991 Zoogeographical affinities of Mexican aquatic Heteroptera. *Bull. North Amer. Benthol. Soc.* 8(1):71. (Abstract, No. 63)
126. 1991 A new and primitive genus of Cryphocricinae (Heteroptera: Naucoridae). *Pan Pac. Entomol.* 67(2):119-123.
127. 1991 Three new species of marine water striders from the Australasian region, with notes on other species (Gerridae: Halobatinae, Trepobatinae). *Raffles Bull. Zool.* 39(1):1-13. (Co-author; D. A. Polhemus, junior author).
128. 1991 Three new species of *Salduncula* Brown from the Malay Archipelago, with a key to the known species (Heteroptera: Saldidae). *Raffles Bull. Zool.* 39(1):153-160.
129. 1991 A review of the veliid fauna of bromeliads, with a key and description of a new species (Heteroptera: Veliidae). *J. New York Entomol. Soc.* 99(2):204-216. (Co-author; D. A. Polhemus, junior author).
130. 1991 Distributional data and new synonymy for species of *Halobates* Eschscholtz (Heteroptera: Gerridae) occurring on Aldabra and nearby atolls, western Indian Ocean. *J. New York Entomol. Soc.* 99(2):217-223. (Co-author; D. A. Polhemus, senior author).
131. 1991 The scientific publications of Roland Fountain Hussey 1916-1968. *Insecta Mundi* 5(1):61-63.
132. 1991 A revision of the Leptopodomorpha (Heteroptera) of Madagascar and nearby Indian Ocean Islands. *J. New York Entomol. Soc.* 99(3):496-526. (Co-author; D. A. Polhemus, junior author).
133. 1991 Hemiptera, infraorder Gerromorpha (Amphibocorisae, Amphibocoromorpha), pp. 482-485 in *Insects of Australia*, 2nd edition, Vol. I. Melbourne University Press, Carlton, Victoria, 560 pp. (Co-author, with G. F. Gross, senior author, I. Lansbury and T. A. Weir).
134. 1991 Hemiptera, infraorder Leptopodomorpha, p. 485 in *Insects of Australia*, 2nd edition, Vol. I. Melbourne University Press, Carlton, Victoria, 560 pp. (Co-author, with G. F. Gross, senior author, I. Lansbury and T. A. Weir).
135. 1991 Hemiptera, infraorder Nepomorpha (Hydrocorisae, Crpytocerata), pp. 486-488 in *Insects of Australia*, 2nd edition, Vol. I. Melbourne University Press, Carlton, Victoria, 560 pp. (Co-author, with G. F. Gross, senior author, I. Lansbury and T. A. Weir).
136. 1992 Nomenclatural notes on aquatic and semiaquatic Heteroptera. *J. Kansas Entomol. Soc.* 64(4):438-443, 1991.
137. 1992 The identity and synonymy of *Hydroessa fusca* Germar (Veliidae: Heteroptera). *J. New York Entomol. Soc.* 100(1):180-181.
138. 1992 Taxonomy of *Saldula*: revised genus and species group definitions, and a new species of the *pallipes* group from Tunisia (Heteroptera: Saldidae). *Entomol. Scand.* 22:63-88. (Co-author; P. Lindskog, senior author).

139. 1992 Marine Heteroptera of the Eastern Tropical Pacific, pp 302–320 in Quintero, D. and A. Aiello (eds.), *Insects of Panama and Mesoamerica*. Oxford University Press, Oxford, xxii + 692 pp. (Co-author; M. del R. Manzano, junior author).
140. 1992 New distributional records for semiaquatic Heteroptera, including a *Microvelia* new to the United States (Heteroptera: Hydrometridae, Saldidae, Veliidae). *J. New York Entomol. Soc.* 100:533–534.
141. 1992 Occurrence of *Microvelia douglasi douglasi* Scott (Veliidae: Heteroptera) in Tamil Nadu. *J. Biological Control* 6(1):41. (Co-authors; P. Narayanasamy, senior author, and J. Nirmala).
142. 1993 Case 2829. *Notonecta obliqua* Gallén, 1787 (Insecta, Hemiptera): proposed conservation of the specific name. *Bull. Zool. Nomen.* 50(2): 118–120. (Co-author; A. Jansson, senior author).
143. 1993 Case 2830. *Corisa nigrolineata* Fieber, 1848 [currently *Sigara (Pseudovermicorixa) nigrolineata nigrolineata*] (Insecta, Heteroptera): proposed conservation of the specific name. *Bull. Zool. Nomen.* 50(2): 121–123. (Co-author; A. Jansson, senior author).
144. 1993 Book review—ecology of aquatic insects, Vol. 1. Biology and habitat. J. V. Ward. *Amer. Entomol.* 39(2):122–123.
145. 1993 A review of the genus *Rhagadotarsus* with descriptions of three new species (Heteroptera: Gerridae). *Raffles Bull. Zool.* 41(1):95–112. (Co-author; P. B. Karunaratne, junior author).
146. 1993 Two new genera for New World Veliinae (Heteroptera: Veliidae). *J. New York Entomol. Soc.* 101(3):391–398. (Co-author; D. A. Polhemus, junior author).
147. 1993 Overlooked names in Nepomorpha, new synonymy, and a new name (Heteroptera: Corixidae, Notonectidae). *J. New York Entomol. Soc.* 101(3):431–433.
148. 1993 The Trepobatinae (Gerridae) of New Guinea and surrounding regions, with a review of the world fauna. Part 1. Tribe Metrobatini. *Entomol. Scand.*, 24:241–284. (Co-author; D. A. Polhemus, junior author).
149. 1994 The Nepidae (Hemiptera) of the United States and Canada. *Annals Entomol. Soc. America*, 87:27–42. (Co-author; R. W. Sites, senior author).
150. 1994 A new species of *Aquarius* (Heteroptera: Gerridae) from Timor, with notes on Timorese zoogeography. *Proc. Entomol. Soc. Wash.* 96(1): 54–62. (Co-author; D. A. Polhemus, senior author).
151. 1994 The synonymy of *Gerris comatus comatus* Drake and Hottes and *Gerris comatus mickeli* Drake and Hottes (Heteroptera: Gerridae). *Proc. Entomol. Soc. Wash.* 96(1):178.
152. 1994 A new species of *Pentacora* (Heteroptera: Saldidae) from the Ouachita Mountains of Arkansas. *J. Kansas Entomol. Soc.* 66:455–457, 1993.
153. 1994 Four new genera of Microveliinae (Heteroptera) from New Guinea. *Tijdschr. Entomol.* 137:57–74. (Co-author; D. A. Polhemus, junior author).
154. 1994 New synonymy in the genus *Anisops* Spinola (Notonectidae: Heteroptera). *Proc. Entomol. Soc. Wash.* 96(3):579.

155. 1994 Key to Chinese families of adult aquatic and semiaquatic Heteroptera, pp. 212, 216, Ch. 13, in Morse, J. C., L. Yang and L. Tian (eds.), Aquatic insects of China useful for monitoring water quality. Hohai Univ. Press, Nanjing, xi + 570 pp. (Co-author; Leyi Zheng, senior author).
156. 1994 Keys to Chinese genera of adult aquatic and semiaquatic Heteroptera, Belostomatidae, p. 217, Ch. 13, in Morse, J. C., L. Yang and L. Tian (eds.), Aquatic Insects of China Useful for Monitoring Water Quality. Hohai Univ. Press, Nanjing, xi + 570 pp. (Co-author; Guoqing Liu, senior author).
157. 1994 The stridulatory mechanism of *Nerthra* Say, a new species, and synonymy. (Gelastocoridae: Heteroptera). J. New York Entomol. Soc. 102(2):242–248. (P. Lindskog, junior author).
158. 1994 A new species of *Ambrysus* Stål from Ash Meadows, Nevada (Nau-coridae, Heteroptera). J. New York Entomol. Soc. 102(2):261–265. (Co-author; D. A. Polhemus, junior author).
159. 1994 Stridulatory mechanisms in aquatic and semiaquatic Heteroptera. J. New York Entomol. Soc. 102 (2):270–274.
160. 1994 The Trepobatinae (Gerridae) of New Guinea and surrounding regions, with a review of the world fauna. Part 2. Tribe Naboandelini. Entomol. Scand. 25:333–359. (Co-author; D. A. Polhemus, junior author).
161. 1994 The identity and synonymy of the Belostomatidae (Heteroptera) of Johann Christian Fabricius 1775–1803. Proc. Entomol. Soc. Wash. 96(4):687–695.
162. 1994 Synonymical notes on the *Nepa cinerea* Linnaeus complex (Nepidae: Heteroptera). Tijdschr. Entomol. 137:331–336. (Co-author; N. Nieser, S. L. Keffer, junior authors).
163. 1995 The identity and synonymy of *Nepa fusca* Linnaeus, 1758 (Heteroptera: Nepidae). Proc. Entomol. Soc. Wash. 97(1):123–127.
164. 1995 A review of the genus *Stridulivelia* Hungerford and two new species (Heteroptera, Veliidae) from South America. Proc. Entomol. Soc. Wash. 97(1):128–152. (Co-author; P. J. Spangler, junior author).
165. 1995 A new species of *Leotichius* from Bali, with notes on immature stages and habitat (Heteroptera, Leptopodidae). J. New York Entomol. Soc. 102(3):367–373. (Co-author; R. T. Schuh, junior author).
166. 1995 Neotype designation for *Ranatra americana edentula* Montandon (Heteroptera: Nepidae). J. New York Entomol. Soc. 102(3):381–383.
167. 1995 The Trepobatinae (Gerridae) of New Guinea and surrounding regions, with a review of the world fauna. Part 3. Tribe Trepobatini. Entomol. Scand. 26:97–118. (Co-author; D. A. Polhemus, junior author).
168. 1995 *Nepa rustica* Fabricius, 1781 and *Zaitha stollii* Amyot & Serville 1843 (currently *Diplonychus rusticus* and *Belostoma stollii*; Insecta: Heteroptera): proposed conservation of the specific names. Bull. Zool. Nomencl. 52(1):40–43. (Co-author; I. M. Kerzhner, junior author).
169. 1995 The aquatic and semiaquatic Heteroptera of the Rocky Mountain Region. Bull. North Amer. Benthological Soc. 12(10):124 (Abstract).
170. 1995 Infraorder Nepomorpha—water bugs (introduction), pp. 13–14 in Au-

- kema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
171. 1995 Family Nepidae Latreille, 1802—water scorpions, water stick insects, pp. 14–18 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
172. 1995 Family Belostomatidae Leach, 1815—giant water bugs, electric light bugs, toe biters, pp. 19–23 in Aukema, B. & C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
173. 1995 Family Gelastocoridae Kirkaldy, 1897—toad bugs, pp. 23–25 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
174. 1995 Family Ochteridae Kirkaldy, 1906—velvety shore bugs, pp. 25–26 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
175. 1995 Family Naucoridae Leach, 1815—creeping water bugs, saucer bugs, pp. 57–60 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
176. 1995 Family Notonectidae Latreille, 1802—backswimmers, pp. 63–73 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
177. 1995 Family Pleidae Fieber, 1851—pygmy backswimmers, pp. 73–75 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
178. 1995 Family Helotrephidae Esaki & China, 1927—BB bugs, pp. 75–76 in Aukema, B. and C. Rieger (eds.), Catalogue of the Heteroptera of the Palearctic Region. Netherlands Entomological Society, Amsterdam, xxvi + 222 pp.
179. 1995 A phylogenetic review of the *Potamobates* fauna of Colombia (Heteroptera: Gerridae), with descriptions of three new species. Proc. Entomol. Soc. Wash. 97(2):350–372. (Co-author; D. A. Polhemus, junior author).
180. 1995 A primitive new species of *Hydrometra* from Tahiti (Heteroptera: Hydrometridae). Bishop Mus. Occ. Pap. 43:1–4. (Co-author; D. A. Polhemus, junior author).
181. 1995 A new species of *Hydrometra* from the Seychelles (Heteroptera: Hydrometridae). Bishop Mus. Occ. Pap. 43:5–8. (Co-author; D. A. Polhemus, junior author).
182. 1995 Revision of the genus *Hydrometra* Latreille in Indochina and the west-

- ern Malay Archipelago (Heteroptera: Hydrometridae). Bishop Mus. Occ. Pap. 43:9-72. (Co-author; D. A. Polhemus, junior author).
183. 1995 Nomenclatural and synonymical notes on the genera *Diplonychus* Laporte and *Appasus* Amyot & Serville (Heteroptera: Belostomatidae). Proc. Entomol. Soc. Wash. 97(3):649-653.
184. 1995 The identity of *Pelocoris biimpressus* Montandon and synonymy of *Pelocoris* species in the southwestern United States (Heteroptera: Naucoridae). Proc. Entomol. Soc. Wash. 97(3):654-658. (Co-author; R. W. Sites, junior author).
185. 1995 A fossil hebrid from Chiapas Amber (Heteroptera, Hebridae). Pan-Pac. Entomol. 71(2):78-81.
186. 1995 The *Pelocoris* (Heteroptera: Naucoridae) fauna of Texas. Southwestern Naturalist. 40(3):249-254. (Co-author; R. W. Sites, senior author).
187. 1995 Aquatic and semiaquatic Hemiptera, pp. 267-297 in R. W. Merritt and K. W. Cummins (eds.), An Introduction to the Aquatic Insects of North America, 3rd edition. Kendall/Hunt, Dubuque, xxiii + 862 pp.
188. 1996 New Hawaiian island records for Aquatic Heteroptera (Insecta). Bishop Museum Occ. Pap. 46:34-35.
189. 1996 An overlooked paper on Heteroptera by N. A. Kormilev. Proc. Entomol. Soc. Wash. 98(2):376.
190. 1996 The Trepobatinae (Gerridae) of New Guinea and surrounding regions, with a review of the world fauna. Part 4. Tribe Stenobatini. Entomol. Scand. 27:279-346. (Co-author; D. A. Polhemus, junior author).
191. 1996 Phallic phylogeny—the relationships of Trepobatine water striders (Gerridae) based on deep genitalic structures. Proc. XX Int. Congr. Entomol., Firenze, Italy, August 25-31, 1996, p. 339. Abstract 11-005. (Co-author; D. A. Polhemus, junior author).
192. 1996 Assembling New Guinea—40 million years of island arc accretion as indicated by the distribution of aquatic Heteroptera. Proc. XX Int. Congr. Entomol., Firenze, Italy, August 25-31, 1996, p. 75. Abstract 02-023. (Co-author; D. A. Polhemus, senior author).
193. 1996 A new genus of Microveliinae from treeholes in Kenya (Veliidae: Heteroptera). Tijdschr. Entomol. 139:73-77. (Co-author; R. C. Copeland, junior author).
194. 1996 Aquatic and semiaquatic Hemiptera, pp. 267-297 in R. W. Merritt and K. W. Cummins (eds.), An Introduction to the Aquatic Insects of North America, 3rd edition, Second Printing (revised). Kendall/Hunt, Dubuque, xxiii + 862 pp.
195. 1997 Revision of the genus *Hydrometra* Latreille in Australia, Melanesia and the Southwest Pacific (Heteroptera: Hydrometridae). Bishop Mus. Occ. Pap. 47:1-67. (Co-author; I. Lansbury, junior author).
196. 1997 *Synaptonecta issa* (Distant), first new world record of an Asian water bug in Florida (Heteroptera: Corixidae). Entomol. News 108:300-304. (Co-author; R. Rutter, junior author).
197. 1997 New state and U. S. records and other distributional notes for Heteroptera (Insecta). Entomol. News 108:305-310.
198. 1997 Aquatic Heteroptera, pp. 31-41 in Webb, D. W. (ed.), Current and

- Selected Bibliographies on Benthic Biology, 1996. North American Benthological Society, NABS Bibliography, Champaign, IL., 3 + 96 pp. (Co-author; A. Brigham, junior author).
199. 1997 A new species of *Tenagobia* (Heteroptera: Corixidae) from Venezuela. Entomol. News 108:379–381. (Co-author; N. Nieser, junior author).
200. 1997 Seven new species of *Hydrotrepes* China (Helotrephidae: Heteroptera) from Sulawesi. Tijdschr. Entomol. 140:43–54.
201. 1997 Five new *Potamometropsis* species (Insecta: Heteroptera: Gerridae) from Borneo. Annalen des Naturhistorisches Museums in Wien 99(B): 21–40. (Co-author; H. Zettel, junior author).
202. 1998 Redescription of *Nerthra praecipua* (Heteroptera: Gelastocoridae) from Chile. Entomol. News 109:33–36. (Co-author; T. Cekalovic K., junior author).
203. 1998 A review of the genus *Limnometra* Mayr in New Guinea, with the description of a very large new species (Heteroptera: Gerridae). J. New York Entomol. Soc. 105:24–39. (Co-author; D. A. Polhemus, senior author).
204. 1998 Introduction to the Nepidae of Thailand. Amemboa 2:19–23. (Co-author; N. Nieser, senior author).
205. 1998 Two new species of *Hynesionella* (Heteroptera: Gerridae) from South Africa. Entomol. News 109:191–194.
206. 1998 Assembling New Guinea: 40 million years of island arc accretion as indicated by the distributions of aquatic Heteroptera (Insecta), pp. 327–340 in R. Hall and J. D. Holloway (eds.), Biogeography and Geological Evolution of SE Asia. Royal Holloway, University of London, London, ii + 417 pp., 167 figs., 12 col. pls. (Co-author; D. A. Polhemus, senior author).
207. 1998 Aquatic Heteroptera, pp. 42–48 in Webb, D. W. (ed.), Current and Selected Bibliographies on Benthic Biology, 1997. North American Benthological Society, NABS Bibliography, Champaign, IL., 3 + 116 pp.
208. 1998 A revision of the genus *Helotrephes* Stål, 1860 (Insecta: Heteroptera: Helotrephidae) with descriptions of twelve new taxa from the Oriental Realm. Annalen des Naturhistorisches Museums in Wien 100(B):99–136. (Co-author; H. Zettel, senior author).

APPENDIX 1: TAXA PROPOSED IN HONOR OF JOHN T. POLHEMUS

FUNGI

LABOULBENIACEAE

Rhizopodomyces **polhemusii** Benjamin 1979*Tavaresiella* **polhemi** Benjamin 1993

ARACHNIDA

SOLPUGIDA

Eremobates **polhemusi** Muma & Brookhart 1988

INSECTA

*GERRIDAE**Tarsotrechus* **polhemi** Andersen 1979*Trepobates* **polhemi** Kittle 1982*Ventidius* **polhemorum** Chen & Zettel 1999*HELOTREPHIDAE***Polhemotrephes** n. subgenus, Zettel 1995*LYGAEIDAE**Botocudo* **polhemusi** J. A. Slater & D. Polhemus 1987*MESOVELIIDAE**Mesovelia* **polhemi** Spangler 1990*MIRIDAE**Eurychiloptera* **polhemusi** Stonedahl 1996*Phytocoris* **polhemusi** Stonedahl 1988*OCHTERIDAE**Ochterus* **polhemusi** Gapud 1981*VELIIDAE**Halovelia* **polhemi** Andersen 1989*Rhagovelia* **johnpolhemi** D. Polhemus 1997

APPENDIX 2: TYPE REPOSITORIES AND ACRONYMS

AMNH, American Museum of Natural History, New York
ANIC, Australian National Collection, Canberra
BMNH, British Museum of Natural History, now The Natural History Museum, London
BPBM, B. P. Bishop Museum, Honolulu
CAS, California Academy of Sciences, San Francisco
CNTN, Nieser Collection, Tiel, The Netherlands
DSIR, Division of Industrial and Scientific Research, Auckland
INPA, Instituto Nacional de Pesquisas da Amazonia, Manaus
JTPC, J. T. Polhemus Collection, Englewood (eventually to be placed in USNM)
LACM, Los Angeles County Museum of Natural History, Los Angeles
MHNG, Natural History Museum, Geneva
MZHF, Zoological Museum, Finnish Museum of Natural History, Helsinki
NHMW, Naturhistorisches Museum Wien, Vienna
NHRM, Naturhistoriska Riksmuseet, Stockholm
NMKE, National Museum of Kenya, Nairobi
NMSC, Zoological Reference Collection, Singapore
QBUM, Museu Nacional, Quinta da Boa Vista, Rio de Janeiro
RMNH, Nationaal Natuurhistorische Museum, Leiden
SEMC, Snow Entomological Museum Collection, Lawrence
UCMC, University of Colorado, Boulder
UCPM, University of California Paleontological Museum, Berkeley
USNM, United States National Museum of Natural History, Washington
ZMAS, Zoological Museum, Russian Academy of Sciences, Leningrad
ZMUC, Zoological Museum, University of Copenhagen, Denmark
ZSMC, Zoologische Staatssammlung, Munich

NOTES ON THE VELIIDAE (HETEROPTERA) OF BORNEO: 2. *POLHEMOVELIA* N.GEN., WITH DESCRIPTION OF THREE NEW SPECIES

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Abstract.—*Polhemovelina* n.gen. and three new species, *P. septuaginta* n.sp. (type species), *P. johnpolhemi* n.sp., and *P. setosa* n.sp., are described from Northern Borneo (Malaysia, Sabah). This new genus of Microveliini is compared with other similar genera which are distributed in the tropics of the Old World. Two of the three species were found to be hygropetric. Adaptations to (semi-)terrestrial habits in Microveliinae are discussed.

Key words: Heteroptera, Veliidae, Microveliinae, Microveliini, *Polhemovelina*, new genus, new species, key, phylogeny, hygropetric, Borneo.

Material collected by the senior author during a research study in Sabah in 1997 and additional specimens deposited in the National Natural History Museum (NNM, Leiden), the John T. Polhemus Collection (JTPC, Englewood), and the Natural History Museum Vienna (NHMW) belong to a new genus of Microveliini sensu Štys, 1976 (excluding the Microveliinae genera *Hebrovelia* Lundblad, 1939, and *Velohebria* Štys, 1976, both with subterminal claws). Although there is presently no phylogenetic analysis of Microveliinae available (see Andersen, 1982, 1989; Polhemus and Polhemus, 1994; Zettel, 1998), the three new species clearly form a separate clade of Microveliini, which is closely related to the Oriental genera *Baptista* Distant, 1903, *Neoalardus* Distant, 1912, and *Lathriovelina* Andersen, 1989, and similar to the New Guinean genera *Tanyvelia* Polhemus and Polhemus, 1994, and *Aegilipsicola* Polhemus and Polhemus, 1994. The Oriental fauna is very rich in different clades of Microveliini, partly of generic rank, and partly still included in *Microvelia* s.l. Several studies on these clades have to be done in preparation for a cladistic analysis of the microveliine genera.

In the key to the Veliidae genera of Thailand and adjacent countries by the junior author (Hecher 1998), *Polhemovelina* gen.n. would key out together with *Baptista*, from which it is easy to distinguish by the lack of modifications on the male forelegs and male abdomen, by the very long antennae, and by the short, club-shaped parameres.

All specimens studied are macropterous.

Repositories.

JTPC Coll. J.T. Polhemus, Englewood, Colorado, U.S.A.

NHMW Naturhistorisches Museum in Wien, Vienna, Austria

NNM National Museum of Natural History, Leiden, The Netherlands

UMS Universiti Malaysia Sabah, Kota Kinabalu, Malaysia

Polhemovelina, new genus

Type species. *Polhemovelina septuaginta* n.sp.

Diagnosis. Medium to large sized, slender, elongate Microveliinae; male slightly

smaller than female; head directed anteriad, posteriorly produced, inserted in an emargination of the anterior margin of the pronotum; eyes very close to anterior margin of pronotum (Fig. 1); antenna very long and slender, total length 78–106% of body length, with segment 1 as long as or longer than head width (1.0–1.2 times), with segments 3 and 4 subequal in length, very long and filiform (Figs. 1, 7); rostrum surpassing anterior margin of mesosternum; propleura anteriorly produced; legs very long and slender (Figs. 1, 8–11); protibia of male with relatively short (one fifth to one fourth of protibial length), but elongate grasping comb (Figs. 9–11); legs of male without further modifications; segments of meso- and metatarsi subequal in length; claws preterminal, simple; only macropterous morph known; forewing with four closed cells, distal cells large, the posterior cells larger than the corresponding anterior cells (Figs. 4–6); abdomen of both sexes elongate, relatively flat, otherwise unmodified; male segment 8 small, strongly depressed, with shallow ventral impression (Figs. 18–20); pygophore and proctiger of male small, proctiger posteriorly pointed (indistinct in *P. johnpolhemi* n.sp.; Figs. 21–23); left and right paramere of same shape, small, clubshaped (Figs. 24–26); gonocoxa of female uncovered, directed posteriad; tergite 8 and proctiger of female directed posteriad (Figs. 15–17); female proctiger terminating in an acute spine (indistinct in *P. johnpolhemi* n.sp.).

Discussion. Andersen (1989: tab. 1) presented a comparison of thirteen Microveliinae genera based on a set of twelve diagnostic characters. Some characters of *Polhemovelina*, like the modifications of the head insertion and anterior part of the pronotum (presently regarded as an important character for a differentiation of genera; see Andersen 1982, 1989), the elongate body shape, and relatively long antennae and legs are typical for the Microveliini genera *Aegilipsicola*, *Baptista*, *Gracilovelina* Poisson, 1948, *Lathriovelina*, *Neoalardus*, *Tanyvelina*, and *Tenagovelina* Kirkaldy, 1908. These genera differ from *Polhemovelina* gen.n. as follows:

Aegilipsicola (one species; New Guinea): hemelytron of macropterous morph with five closed cells, and with bluish pruinose streaks, but without white spots; claws extremely long; male profemur with modifications (thickened, hair tuft); male protibia with very long grasping comb ($\frac{3}{4}$ of protibial length); parameres small, lobe-shaped (Polhemus and Polhemus, 1994).

Baptista (four species; India and Southeast Asian mainland): antenna not very long; foreleg of male usually with obvious additional modifications (but not in an undescribed species from Burma; Dan A. Polhemus, pers. comm.); male abdominal segments 6 and/or 7 with distinct modifications; parameres falciform (Andersen, 1989).

Gracilovelina (one species; West Africa): male much larger than female; antenna much shorter than body length; protibial grasping comb very short (about $\frac{1}{10}$ of protibial length); parameres falciform (Poisson, 1955).

Lathriovelina (two species; Malaysia): eyes distinctly removed from the anterior margin of pronotum; antenna relatively short; profemur of male modified; segment 8 of male with one pair of tubercles; parameres falciform (Andersen, 1989).

Neoalardus (one species; from India to Sumatra): male without grasping comb; parameres medium-sized, with dorsal process (Zettel, 1998).

Tanyvelina (one species; New Guinea): legs long, but relatively stout; male grasping comb extremely long ($\frac{3}{4}$ of protibial length); only brachypterous morph known; paramere acuminate; female gonocoxa small, barely exposed (Polhemus and Polhemus, 1994).

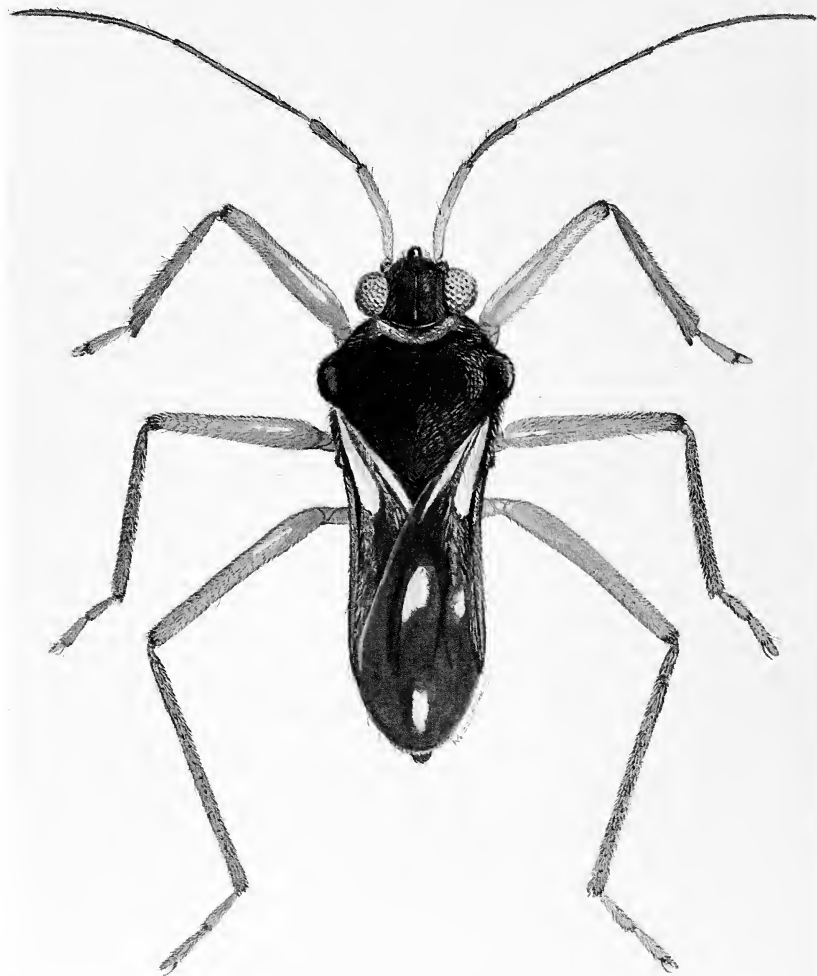
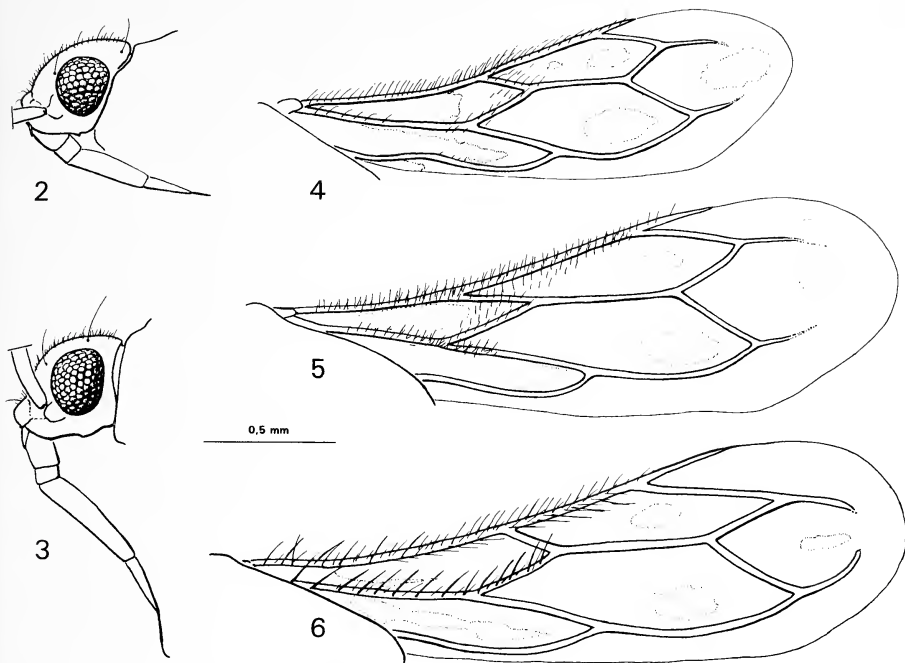


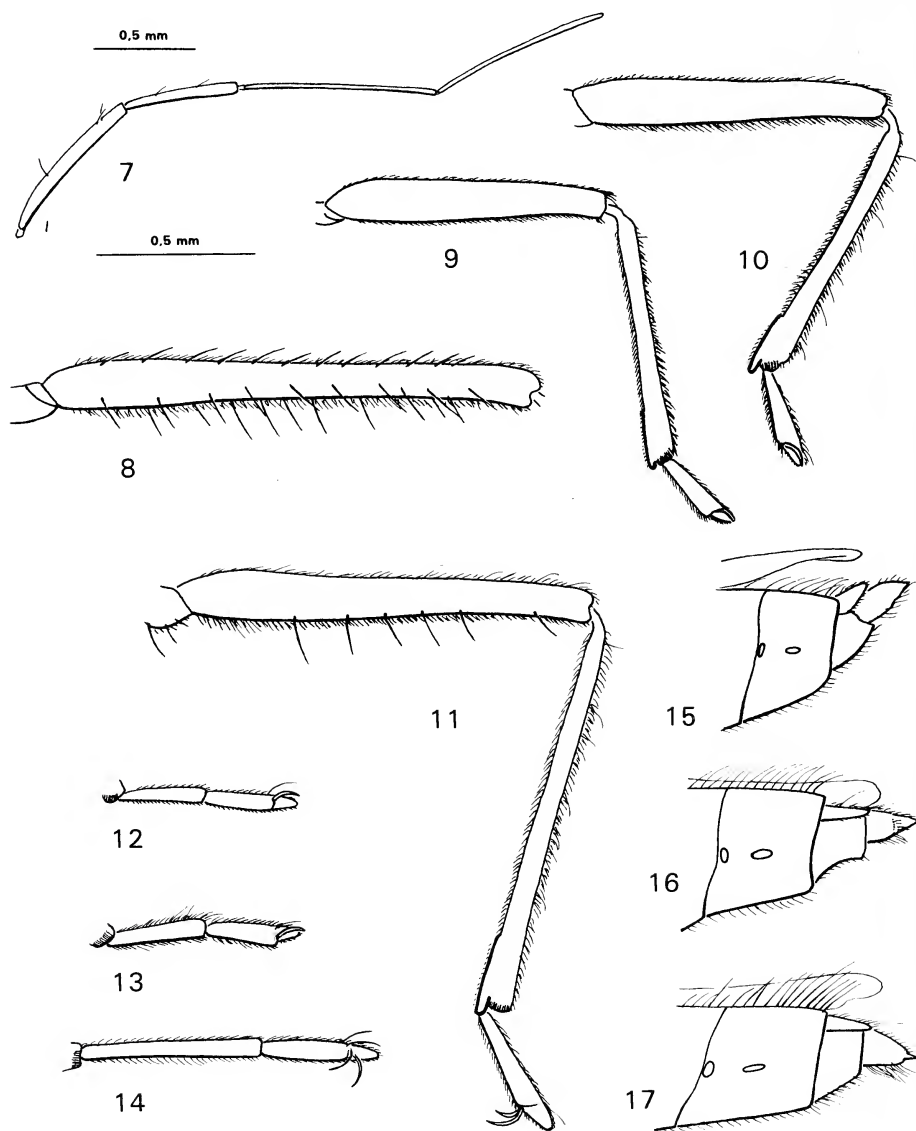
Fig. 1. *Polhemovelina septuaginta* n.gen., n.sp., male, dorsal habitus.



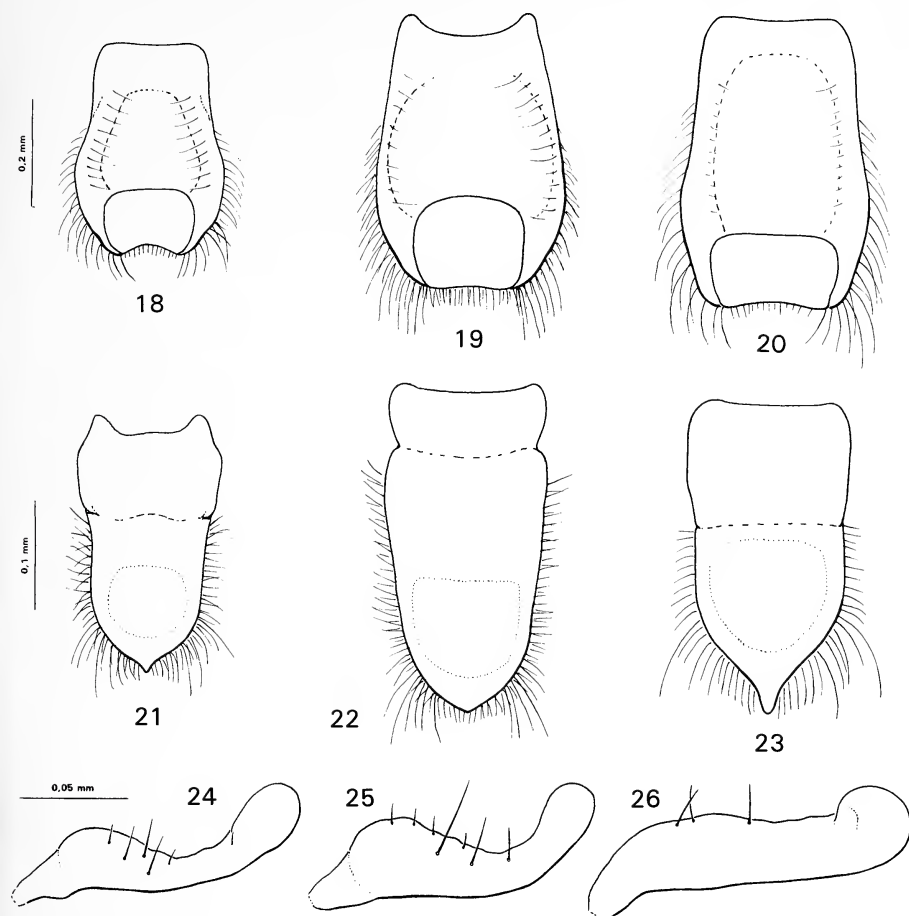
Figs. 2–6. *Polhemovelina* n.gen., structural characters. 2, 3, head, lateral view; 2. *P. septuaginta*, 3. *P. setosa*. 4–6, right forewing (in situ); 4. *P. septuaginta*, 5. *P. johnpolhemi*, 6. *P. setosa*.

Tenagovelina (one species; East and South Africa, Madagascar): body length more than 5.0 mm; whole body with very dense, erect pilosity; antenna much shorter than body, segment 1 longest; profemur of male with tooth; male segment 8 subcylindrical.

All these genera share some characters, i.e. body elongate (and usually large in size), relatively long antennae and legs, the wing venation (four or five large closed cells), the symmetrical (and often large) parameres of male, and the uncovered gonocoxa 1 of female (except *Tanyvelia*), which are probably plesiomorphic, because they are found in several “primitive” genera presently set at the “base” of the Microveliini. However, extreme lengths of appendages (antennae, legs) in combination with an obligatorily or dominantly macropterous condition, as found in *Aegilipsicola*, *Baptista*, *Lathriovelina*, *Neolardus*, and *Polhemovelina*, may be adaptations to specialized, semiterrestrial or terrestrial life habits (for antenna see Štys, 1976), as convergently (also within Microveliinae?; see below) developed in Hebroveliini, Velohebrini, Mesoveliidae, and Gerridae-Eotrechinae. In fact, *Baptista* species are said to live in terrestrial (Linnavuori, 1977), semiterrestrial or small aquatic habitats (Andersen, 1989; Yang and Kovac, 1995); *Lathriovelina* “in the hollow interior of bamboo internodes of *Gigantochloa latifolia*” (Andersen, 1989; Yang and Kovac, 1995); *Neolardus* “on moist sand and mud along a small stream” (Andersen, 1982); *Aegilipsicola* “apparently obligate to hygropetric habitats” (Dan A. Polhemus, pers. comm.); and *Polhemovelina* hygropetric (see below). The question as to whether these adaptations are apomorphic characters of a very old (see wide



Figs. 7-17. *Polhemovelina* n.gen., structural details. 7. *P. setosa*, antenna; 8. *P. setosa*, right mesofemur. 9-11, right foreleg; 9. *P. septuaginta*, 10. *P. johnpolhemi*, 11. *P. setosa*. 12-14, male metatarsus; 12. *P. septuaginta*, 13. *P. johnpolhemi*, 14. *P. setosa*. 15-17, Female terminalia, lateral view; 15. *P. septuaginta*, 16. *P. johnpolhemi*, 17. *P. setosa*.



Figs. 18–26. *Polhemovelina* n.gen., male genitalia. 18–20, segment 8, ventral view; 18. *P. septuaginta*, 19. *P. johnpolhemi*, 20. *P. setosa*. 21–23, proctiger, dorsal view; 21. *P. septuaginta*, 22. *P. johnpolhemi*, 23. *P. setosa*. 24–26, left paramere, external view; 24. *P. septuaginta*, 25. *P. johnpolhemi*, 26. *P. setosa*. Pilosity in Figs. 18–23 half-schematic, only along contours and characteristic mediad directed hairs of segment 8.

distribution!) clad of *Microveliinae* or have developed convergently several times, cannot be answered at present. Convergences of hygropetric life and body adaptations have also been observed in an undescribed *Microvelia* species (with very long middle and hind legs, but short antenna) from Australia, Northern Territories (H. Gross, pers. comm.), which seems to be otherwise closely related to other Australian *Microvelia* species.

It should be also considered that *Hebrovelia* and *Velohebria* may have perfected their adaptations to terrestrial habits by secondarily subterminal claws, as this is indicated in the gerrid genus *Eotrechus* Kirkaldy, 1902. In this case the positions of

the claws in *Hebrowelia* and *Velohebria* are not symplesiomorphic as suggested by Štys (1976), but apparently convergently apomorphic. Consequently *Hebrowelia* and *Velohebria* could be more closely related with one or some of the genera treated above. If this is true, the present concept of the three tribes within the subfamily Microveliinae has to be totally revised. Moreover, the flagelliform antennal segments 3 and 4, the second main character used by Štys (1976) to separate the tribes Hebroweliini and Velohebrini from the Microveliini, is also found in certain genera of Microveliini, e.g., in *Aegilipsicola*, *Neoalardus*, *Polhemovelina*, and *Tanyvelina*.

Distribution. So far only known from Sabah, North Borneo.

Habitats. All *Polhemovelina* species live in stream habitats in primary or secondary evergreen rain forests (lowland, submontane, or montane). One species, *P. setosa* n.sp., was collected at light. The other two species, *P. septuaginta* n.sp. and *P. johnpolhemi* n.sp. were found to be hygropetric on shady banks. A relatively large series of *P. septuaginta* n.sp. was collected from a wet, mossy rockface bank of a small stream in the Danum Valley.

Etymology. The new genus is named in honour of Dr. John T. Polhemus, an entomofanatic in the best meaning, who dedicated — during all periods of his life — and still dedicates most of his free time to research on the aquatic, semiaquatic, and shore inhabiting Heteroptera of the world.

KEY TO THE *POLHEMOVELINA* SPECIES

1. Metatarsus long, segment 1 about 1.3–1.5 times as long as segment 2 (Fig. 14); femora with numerous erect bristles which are longer than the width of the femur (Figs. 8, 11); hemelytral pilosity confined to veins (Fig. 6); body length 3.4–4.1 mm . . . *P. setosa* n.sp.
- Metatarsus shorter, segments subequal in length (Figs. 12, 13); femora at most with a few erect hairs which are much shorter than the width of the femur (Figs. 9, 10); some hemelytral pilosity also on anterior cells (Figs. 4, 5); body length less than 3.5 mm . . . 2
2. Body length 3.2–3.4 mm; antennal segments 1 + 2 longer than segment 3; white stripes on corium of equal width (Fig. 5) *P. johnpolhemi* n.sp.
- Body length 2.4–2.9 mm; antennal segments 1 + 2 of subequal length as segment 3 (Fig. 1); posterior white stripe on corium more slender than the anterior one (Fig. 4) *P. septuaginta* n.sp.

Polhemovelina septuaginta, new species

Figs. 1, 2, 4, 9, 12, 15, 18, 21, 24

Description. Length: 2.4–2.6 mm (♂), 2.8–2.9 mm (♀); width of head: 0.6–0.7 mm (♂, ♀); width of pronotum: 0.9–1.1 mm (♂, ♀); habitus see Fig. 1.

Male. Color: Head dark brown, antenna brown, with basal part of segment 1 slightly lighter. Rostrum yellow, with apical segment shiny dark brown. Pronotum dark brown, with a narrow transverse stripe near anterior margin light brown. Legs brown, with coxae, trochanters, and basal part of femora yellow. Forewing dark brown with white patches: corium with one long and very slender stripe and with one broader and shorter stripe, membrane with two larger and one smaller spots (Fig. 4). Tergites and laterotergites covered by wings, lateral margin of laterotergites light brown to

reddish brown. Thoracic venter black. Sternites brown, laterally with narrow stripe slightly darker.

Pilosity: Head, pronotum, corium, thoracic venter, and sternites covered with short, decumbent to suberect, light hairs. Antenna and legs with short, dense, suberect, dark bristles. Head, pronotum, and corium with scattered, long, erect hairs or bristles.

Structural characters: Antenna 0.9 times as long as body, relative length of segments 1–4 as 0.7: 0.4: 1.0: 1.1 (Fig. 1). Pronotum 1.2 times as wide as long. Grasping comb on protibia 0.21–0.25 times as long as tibia (Fig. 9). Metatarsus 0.4 times as long as metatibia, first segment 0.83–0.92 times as long as segment 2 (Fig. 12).

Genital segments: Segment 8 slender, ventral impression indistinct, apical portion with short, decumbent and long, erect hairs (Fig. 18); pygophore without modifications; proctiger posteriorly pointed (Fig. 21); paramere in middle of length slender (Fig. 24).

Female. Characters as in male except the following: Long bristles additionally on lateral margin of laterotergite 7. Antenna 0.8 times as long as body. Protibia without grasping comb.

Genital segments: Gonocoxa and proctiger covered with dense, short, suberect hairs; gonocoxa in lateral view with ventral margin convex (Fig. 15); proctiger terminating in an acute spine.

Types. Holotype, ♂, MALAYSIA, **Sabah**, Danum Valley, Sapat Kalisan, 12.ii.1997, leg. H. Zettel (15) (UMS); Paratypes: 7 ♂, 7 ♀, same locality data (NHMW, UMS, JTPC).

Discussion. See key and notes under the following species.

Distribution. Sabah (Danum Valley).

Etymology. *septuaginta* (Latin, substantive), meaning “seventy”, named after the occasion of the seventieth birthday of John T. Polhemus.

***Polhemovelina johnpolhemi*, new species**

Figs. 5, 10, 13, 16, 19, 22, 25

Description. Length: 3.2 mm (♂), 3.4 mm (♀); width of head: 0.6–0.7 mm (♂, ♀); width of pronotum: 1.1–1.2 mm (♂, ♀).

Male. Color: Head dark brown, antennae brown, with basal part of segment 1 slightly lighter. Pronotum dark brown, with transverse, narrow stripe near anterior margin lighter brown. Legs brown, with coxae, trochanters, and basal part of femora yellow. Forewing dark brown with white patches: corium with two stripes of equal width, inner stripe longer, membrane with three spots (Fig. 5). Tergites and laterotergites covered by wings. Thoracic venter black. Sternites brown, laterally with narrow stripe slightly darker, lateral margin of sternites and distal margin of sternite 7 light brown.

Pilosity: Head, pronotum, corium, thoracic venter, and sternites covered with short, decumbent to suberect, light hairs. Antenna and legs with short, dense, suberect, dark bristles, femora with slightly longer, scattered, erect hairs, tibiae with slightly longer, scattered, erect bristles. Head, pronotum, corium, lateral margin of laterotergite 7, and distal margin of sternite 7 with long, erect hairs, especially dense on lateral margin of corium.

Structural characters: Antenna 0.8 times as long as body, relative length of segments

1-4 as 0.8: 0.5: 1.0: 1.0. Pronotum 1.2 times as wide as long. Grasping comb on protibia 0.21 times as long as tibia (Fig. 10). Metatarsus 0.4 times as long as metatibia, first segment as long as segment 2 (Fig. 13).

Genital segments: Segment 8 broad, ventral impression shallow and large, apical portion with short, decumbent and long, erect hairs (Fig. 19); pygophore without modifications; proctiger posteriorly weakly pointed (Fig. 22); paramere constricted in middle of length (Fig. 25).

Female. Characters as in male except the following: White stripes on corium rather indistinct. Long hairs on veins of corium and on lateral margin of laterotergite 7 more bristle-like; length of antenna as in male, relative length of segments 1-4 as 0.9: 0.5: 1: 1.1. Pronotum 1.3 times as wide as long. Protibia without grasping comb. Metatarsus 0.4 times as long as metatibia, first segment 0.85 times as long as segment 2.

Genital segments: Gonocoxa and proctiger covered with dense, short, suberect hairs; gonocoxa in lateral view with ventral margin concave (Fig. 16); proctiger terminating in an acute spine.

Types. Holotype, ♂, MALAYSIA, **Sabah**, Mt. Kinabalu, Liwagu River, 1,500 m, 18.ii.1997, leg. H. Zettel (20) (UMS). Paratype: 1 ♀ MALAYSIA, **Sabah**, Crocker Range, near Tenom, Kalang Waterfall, 16.-18.v.1998, leg. J. Kodada & F. Ciampor (NHMW).

Discussion. *Polhemovelina johnpolhemi* n.sp. is closely related to *P. septuaginta* n.sp., from which it can be distinguished in larger size, more flattened abdomen (comp. Figs. 15 and 16), more extended pruinose coloration of the pronotum, shorter antenna, and less acute tip of proctiger in both sexes. The male differs further in a ventrally more weakly impressed segment 8 (comp. Figs. 18 and 19), the female in the gonocoxa 1, which has the ventral margin slightly concave in lateral view (Fig. 16).

Distribution. Sabah (Mt. Kinabalu and Crocker Range).

***Polhemovelina setosa*, new species**

Figs. 3, 7, 8, 11, 14, 17, 20, 23, 26

Description. Length: 3.4-3.8 mm (♂), 3.9-4.1 mm (♀); width of head: 0.6-0.7 mm (♂, ♀); width of pronotum: 1.1-1.2 mm (♂), 1.3 mm (♀).

Male: Color: Head dark brown to dark reddish brown, antennae brown, with basal part of segment 1 slightly lighter. Pronotum dark brown, with transverse, narrow stripe on anterior margin yellow to light brown and with pronotal humeri sometimes pruinose. Legs brown, with coxae, trochanters, and basal part of femora yellow to light brown. Forewing dark brown with white patches: corium with one long and very slender stripe and with one broader and shorter stripe, both stripes sometimes rather indistinct, membrane with three spots, distal one smaller and sometimes indistinct (Fig. 6). Tergites and laterotergites covered by wings. Thoracic venter dark brown to black. Sternites light brown, laterally with narrow stripe slightly darker.

Pilosity: Head, pronotum, anterior margin of corium, thoracic venter, and sternites covered with short, decumbent to suberect, light hairs. Antenna and legs with short, dense, suberect, dark bristles, femora additionally with numerous long, erect bristles. Head, pronotum, veins of corium, lateral margin of laterotergite 7, and distal margin of sternite 7 with long, erect bristles.

Structural characters: Antenna 0.9-1.1 times as long as body, relative length of

segments 1–4 as 0.9: 0.5–0.6: 1.0: 0.9–1.0 (Fig. 7). Pronotum 1.1–1.2 times as wide as long. Grasping comb on protibia 0.21–0.23 times as long as tibia (Fig. 11). Metatarsus 0.4 times as long as metatibia, first segment 1.36–1.50 times as long as segment 2 (Fig. 14).

Genital segments: Segment 8 broad, ventral impression shallow and large, apical portion with short, decumbent and long, erect hairs (Fig. 20); pygophore without modifications; proctiger posteriorly strongly pointed (Fig. 23); paramere in middle of length weakly constricted (Fig. 26).

Female: Characters as in males except the following: Antenna 0.9 times as long as body, relative length of segments 1–4 as 0.8: 0.5: 1.0: 1.0. Pronotum 1.1–1.2 times as wide as long. Protibia without grasping comb. First metatarsal segment 0.50–0.53 times as long as segment 2.

Genital segments: Gonocoxa and proctiger covered with dense, short, suberect hairs; gonocoxa in lateral view with ventral margin straight (Fig. 17); proctiger ending in spine.

Types. Holotype, ♂, MALAYSIA, NW, **Sabah**, Kinabalu Park, W slope of Kinabalu, between Kg. Kiau Satu and Marai Parai, at light along Sg. Tahuban, 1030 m, untouched submontane evergreen rain forest, 6°04'N 116°30'E, 11.iii.1987, leg. Van Tol & Huisman (NNM); Paratypes: 6 ♂, 9 ♀, same locality data (NNM, NHMW); 3 ♂, 2 ♀, MALAYSIA, **Sabah**, Borneo, Mesilau River, 8 km. N. of Kundessan, 2,100 m, CL 2020, 1.viii.1985, leg. J.T. & D.A. Polhemus (JTPC, 1 ♂ NHMW).

Discussion. *Polhemovelina setosa* sp.n. differs from both congeners in larger size, more elongate shape of the abdomen (more conspicuous in females), strong pilosity of the legs (Figs. 8, 11), long segment 1 of metatarsus (Fig. 14), a differently shaped paramere (comp. Figs. 24, 25 and 26) and a posteriorly more pointed proctiger, especially in the male (Fig. 23).

Distribution. Sabah (Mt. Kinabalu).

Etymology. *setosus*, -a, -um (Latin, adjective) meaning “bristly”; named after the numerous diagnostic bristles of this species, especially those on the femora.

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LITERATURE CITED

Andersen, N. M. 1982. The Semiaquatic Bugs (Hemiptera, Gerromorpha) Phylogeny, Adaptations, Biogeography and Classification. *Entomograph* 3:455 pp.

- Andersen, N. M. 1989. The Old World Microveliinae (Hemiptera: Veliidae). II. Three new species of *Baptista* Distant and a new genus from the Oriental region. *Entomologica scandinavica* 19:363-380.
- Hecher, C. 1998. Key to the genera of Veliidae (Gerromorpha) of Thailand and adjacent countries, with a check-list of genera and species known from Thailand. *Amemboa* 2:3-9.
- Linnavuori, R. 1977. On the taxonomy of the subfamily Microveliinae (Heteroptera, Veliidae) of West and Central Africa. *Annales entomologici fennici* 43:41-65.
- Poisson, R. 1955. *Speologica africana*. A propos d'une faunule d'Hydrocorises de surface, obscuricoles. *Bulletin Institute francaise Africaine noire (A)* 17:1132-1140.
- Polhemus, J. T. and D. A. Polhemus. 1994. Four new genera of Microveliinae (Heteroptera) from New Guinea. *Tijdschrift voor Entomologie* 137:57-74, figs 1-30.
- Štys, P. 1976. *Velohebria antennalis* gen. n., sp. n.—a primitive terrestrial Microveliine from New Guinea, and a revised classification of the family Veliidae (Heteroptera). *Acta entomologica bohemoslovaca* 73:388-403.
- Yang, C. M. and D. Kovac. 1995. A Collection of Aquatic and Semi-aquatic Bugs (Insecta: Hemiptera: Gerromorpha and Nepomorpha) from Temengor Forest Reserve, Hulu Perak, Malaysia. *Malayan Nature Journal* 48:287-295.
- Zettl, H. 1998. On the Oriental genus *Neolardus* Distant, 1912 (Heteroptera: Veliidae). *Linzer biologische Beiträge* 30(2):595-599.

**MICROVELIA POLHEMI, N. SP. (HETEROPTERA: VELIIDAE)
FROM DOMINICAN AMBER: THE FIRST FOSSIL RECORD OF
A PHYTOTELMIC WATER STRIDER**

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Abstract.—A fossil water strider, *Microvelia polhemi* n. sp., is described from the Oligo-Miocene Dominican amber based upon a single macropterous male. This is the first fossil record of the genus *Microvelia* (Microveliinae, Veliidae), one of the most common and widespread genera of semiaquatic bugs (Gerromorpha). Several characters, in particular the striking, white basal markings of the fore wings, affiliate the fossil species with the extant *Microvelia laesslei* Drake and Hussey from Jamaica. The latter belongs to a guild of Neotropical veliids living in phytotelmic habitats, especially pockets of rain-water accumulated between the leaf axils of plants belonging to the family Bromeliaceae. The fossil species may have used the same type of habitat in the Dominican amber forest.

Semiaquatic bugs or water striders (Hemiptera-Heteroptera, infraorder Gerromorpha) are common insects found on water surfaces in freshwater and marine habitats throughout the world (Andersen 1982). Limnic habitats range from large, permanent water bodies (lakes, ponds, rivers, and streams) to small temporary pools or streams. A special type of habitat occupied by water striders is water accumulating in natural containers such as treeholes, bamboo internodes, and water-filled parts of epiphytic plants (collectively called phytotelma; see Wesenberg-Lund, 1943). Most species living in these natural containers are never found in other types of limnic habitats (Andersen, 1982; Polhemus and Polhemus 1991; Polhemus and Copeland, 1996; Yang and Kovac, 1995).

The large amber deposits from the Dominican Republic (Hispaniola, Greater Antilles) are renowned for the taxonomic diversity and preservation quality of their insect inclusions. Most Dominican amber insects belong to terrestrial groups (Poinar, 1992; Grimaldi, 1996), but a few aquatic insects have been described, including the water striders *Electrobates spinipes* Andersen and Poinar (1992) (Gerridae, Electrobatinae) and *Halovelis electrodominica* Andersen and Poinar (1998) (Veliidae, Haloveliinae). Based upon a macropterous male from Dominican amber, I here describe the first fossil species belonging to the water strider subfamily Microveliinae (Veliidae) and to the genus *Microvelia* Westwood (Andersen, 1998). This genus is at present distributed worldwide with more than 200 described species (Andersen, 1982).

The fossil species is named for John T. Polhemus in recognition of his outstanding and life-long contributions to our knowledge about the systematics, faunistics, and biology of aquatic and semiaquatic Hemiptera-Heteroptera of the World.

MATERIAL AND METHODS

One veliid specimen (Figs. 1-2) enclosed in a piece of yellow amber weighting about 0.2 grams. The piece is rectangular with the greatest length = 9.5 mm, the

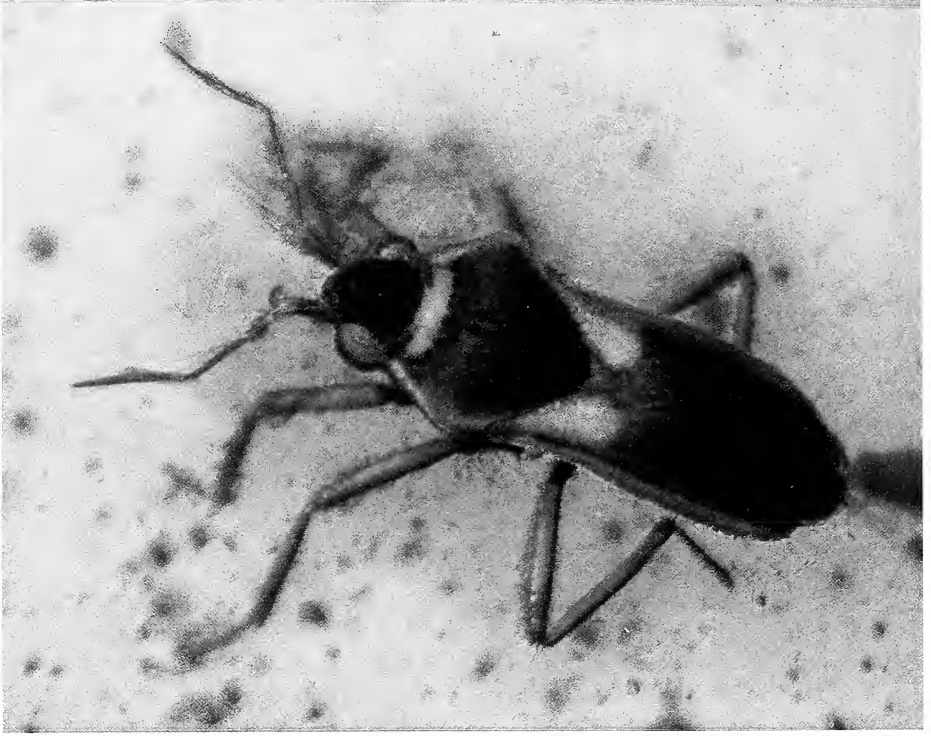


Fig. 1. *Microvelia polhemi* n. sp. Macropterous male holotype from Dominican amber, length 1.85 mm. (Photo G. Brovad, Zoological Museum, University of Copenhagen).

greatest width = 9 mm, and the greatest thickness = 3 mm. The amber piece containing the fossil originates from the El Valle area in the eastern part of the Dominican Republic. The exact age of the Dominican amber deposits is still not known, and estimates based on microfossil and ^{14}C analyses have produced a range from 15–30 myr (Grimaldi, 1995; Iturralde-Vincent and McPhee, 1996).

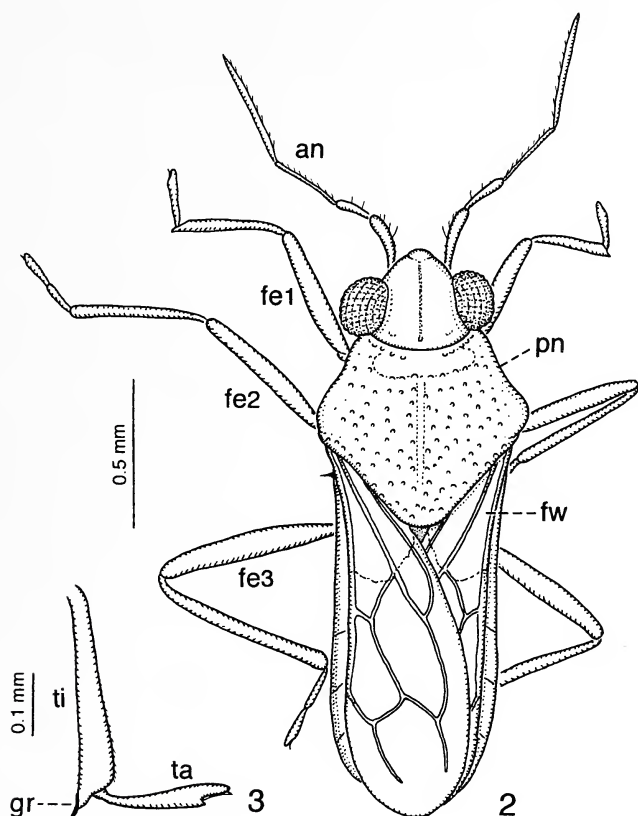
The piece is polished, highly transparent, with few impurities, cracks and fissures. The veliid is located superficially and plainly visible from above. All appendages are preserved *in situ*. The specimen was studied directly or by immersing the piece of amber in glycerin, using fiber optic reflected and incandescent transmitted light. All measurements are given in mm and were made using a ocular micrometer. Total length was measured from the tip of the head to the end of the abdomen. Measurements of antennal segments 3 and 4 include the basal internode. Lengths of the femora are measured along the anterior margin of the segments and do not include the trochanters.

TAXONOMY

Microvelia polhemi, new species

Description.

Size: Holotype, macropterous male, total length 1.85, maximum width 0.7.



Figs. 2–3. *Microvelia polheimi* n. sp. 2, dorsal habitus of macropterous male holotype *in situ*. 3, left fore tibia and tarsus of male. Abbreviations: an, antenna; fe1, fe2, fe3, fore, middle, and hind femora; fw, fore wing; gr, tibial grasping comb; pn, pronotum; ta, tarsus; ti, tibia.

Color and vestiture: Chiefly dark brownish above. Antennae brownish; antennal segments with scattered, semierect, short pubescence. Rostrum yellowish brown. Pronotum with a transverse, pale yellowish marking along anterior margin delimited by transverse rows of dark punctures in front and behind; additional blackish punctures are scattered all over pronotal lobe. Thorax furnished with short and oppressed pubescence. Legs chiefly yellowish brown, femora distally darkened; pubescence of leg segments chiefly short and oppressed. Fore wings chiefly brownish with slightly darker veins; basal third of each wing snowy-white. Ventral surface of thorax and abdomen brownish.

Structure: *Macropterous male* (Figs. 1–2) subovate, length about $2.7\times$ greatest width across pronotum ($1.83:0.69$). *Head* much shorter than wide across eyes ($0.31:0.48$), slightly deflected anteriorly. Dorsal head surface with indistinct median, longitudinal impression and a small circular impression near the hind corner of each eye. Compound eyes globular, diameter about than half maximum width of interocular space ($0.13:0.30$). Antennae long and slender, about $0.6\times$ total length of insect

(1.03: 1.83), inserted obliquely below and close to eye margins; lengths of segments 1-4: 0.23, 0.15, 0.26, and 0.39; first segment curved, surpassing apex of head with more than half its own length, distinctly thicker than segments 2-4; second segment relatively short, slightly thicker than segments 3-4; third segment very slender; fourth segment long, fusiform. Rostrum slender, apex just surpassing posterior margin of prosternum; lengths of segments 1-4: 0.07, 0.04, 0.25, and 0.13. *Thorax*. Pronotum large, pentagonate, median length about $2\times$ length of head (0.60: 0.31), maximum width (across humeral angles) slightly more than median length (0.69: 0.60); anterior margin of pronotum slightly concave, humeral angles prominent, slightly raised, posterior margin produced in middle, covering wing bases. Thoracic sterna subequal in length (0.20). Metasternum with posterior margin slightly produced in middle; median scent orifice indistinct, lateral scent channels curved forwards, ending on metacubacula with tufts of erect hairs. *Legs*. Lengths of leg segments (femur: tibia: tarsus): fore leg: 0.46, 0.39, and 0.21; middle leg: 0.51, 0.46, and 0.28; hind leg: 0.60, 0.60, and 0.29. Fore femora (Fig. 2, fe1) relatively slender (maximum width 0.8); fore tibia (Fig. 3, ti) widened distally, with a very short (0.04) grasping comb (gr) composed of densely set, row of minute, black spinous hairs on the inner surface towards apex; fore tarsus (ta) with a single segment. Middle femora (Fig. 2, fe2) about $0.3\times$ length of insect, slender (width 0.07); tibiae slender and straight; middle tarsi with two segments measuring 0.13 and 0.15, respectively. Hind femora (fe3) slightly thickened (maximum width 0.09); hind tibiae distinctly longer than middle tibiae; hind tarsi with two segments measuring 0.13 and 0.16, respectively. Trochanters of all legs subequal in length (0.14-0.16). Claws small but distinct, inserted preapically on all tarsi. *Wings*: Fore wings (Fig. 2, fw) covering abdomen except connexiva; three longitudinal veins arising from base, branching and reuniting distally, forming four closed cells: two relatively narrow cells in basal part and two larger cells in median part of wings. *Abdomen* relatively long with ventral segmentation fairly distinct; median lengths of sternites 2-7: 0.13, 0.10, 0.10, 0.11, 0.14, and 0.21; abdominal venter slightly depressed, but otherwise not modified; genital segments relatively small (median length 0.20), slightly protruding from abdominal end; parameres not visible externally, presumably small and symmetrically developed.

Types. Holotype, macropterous ♂, contained in a piece of amber originating from the El Valle area in the eastern part of the Dominican Republic; holotype labelled as AMNH no. 10-324 and deposited in the American Museum of Natural History, New York, U.S.A.

Distribution and geological background. Dominican Republic, Hispaniola, Greater Antilles. Age 15-30 myr (Upper Oligocene-Lower Miocene).

DISCUSSION

Classification. The following characters are important in assessing the taxonomic position of the fossil insect:

- (1) Very small winged heteropterous insect, male length only 1.85 mm.
- (2) Dorsal head surface with median, longitudinal impression.
- (3) Eyes relatively large, diameter about half width of interocular space.

- (4) Antennae relatively long and slender; first segment slightly shorter than third segment; second segment slightly shorter than third segment.
- (5) Pronotum of macropterous form large, pentagonate, covering all of meso- and metanotum as well as the wing bases.
- (6) Metasternum with lateral scent channels curving forwards and ending on metacubula in a small tuft of hairs.
- (7) Fore tibia of male with short grasping comb.
- (8) Fore tarsi one-segmented, middle and hind tarsi two-segmented.
- (9) Claws inserted before apex of last tarsal segment.
- (10) Fore wings with few veins which form four closed cells.
- (11) Fore wings with striking, snowy-white basal marks.
- (12) Hind femora slightly longer than middle femora.
- (13) Male genital segments protruding from abdominal end; male parameres not visible externally.

The general structure and especially characters 2, 5, 6, 7, 9, and 10 place the insect in the gerromorphan family Veliidae (Andersen, 1982, 1998). The combination of the characters 8 and 10 are diagnostic for the subfamily Microveliinae. There are about 30 extant genera of this subfamily most of which are keyed out by Andersen (1982: 419). Using this key, the fossil species is identified as belonging to the genus *Microvelia* s. lat. which is worldwide in distribution with more than 200 species. With the exception of the northern temperate regions, the taxonomy of the genus is chiefly based on isolated descriptions of species and largely outdated revisions and reviews. This is in particular the case for the numerous *Microvelia* species known from the Neotropical region. A key character for the fossil species is the bicolored fore wings. Most microveliines have either unicolored, dark wings or dark wings with a number of pale spots.

Polhemus and Polhemus (1991) gave an excellent review of the veliid fauna of bromeliads and keyed out all species known to occur in this type of habitat. Using this key (Polhemus and Polhemus, 1991: 205–207), the small size (less than 2.5 mm), tarsal formula (1:2:2), brownish ground color, and white basal marking on the hemelytra of the fossil species, perfectly match the characters of *Microvelia laesslei*, first described from Jamaica by Drake and Hussey (1954: 134–136). The macropterous form of this species (sex not stated in the original description) measures 2.30 mm (length) and 0.85 mm (width). Thus, even when allowing for sexual size differences, *M. laesslei* is larger and more robust than the fossil species. In addition, the pronotum of *M. laesslei* is uniformly brown or reddish-brown, without a pale transverse marking anteriorly. The third and fourth antennal segments are subequal in length, whereas the fourth segment is distinctly longer than the third segment in the fossil species. *Microvelia polhemi* n. sp. is otherwise very similar to *M. laesslei* in those characters where the state of preservation of the fossil makes a comparison possible.

There are two additional specimens belonging to the genus *Microvelia* in the material of Dominican amber insects deposited at AMNH. One specimen is a macropterous male with rather elongate body, length 1.8 mm; antennae long and slender, and genital segments relatively small; fore tibia apparently without a grasping comb. The other specimen is a very small macropterous male, length 1.35 mm, with relatively short and stout antennae and large genital segments. Further studies, including

comparisons with extant Neotropical species of *Microvelia*, are necessary for assessing the relationships of these fossil water striders.

Biology and ecology. *Microvelia laesslei* Drake and Hussey (1954) was described from both micropterous and macropterous specimens collected from plants belonging to the family Bromeliaceae by Albert M. Laessle, University of Florida, in August and early September, 1952, at Christiana, Juan de Bolas (elevation 2,500 feet), and Mocho (elevation 2,000 feet), Jamaica. These adult specimens, together with numerous nymphs of all ages, were collected by Laessle in an investigation of the fauna of the rain-water pockets of Jamaican bromeliads. The circumstances of these findings are described in the following citations from the original description by C. J. Drake and R. F. Hussey:

"Dr. Laessle investigated numerous species of bromeliads in various parts of Jamaica. The *Microvelia* was found principally in *Aechmea paniculigera* Griseb., and in species of *Hohenbergia* and *Vriesia*. These are large bromeliads, sometimes holding as much as two liters of water; the *Aechmea* has relatively few leaves, and some of its individual axils may contain nearly one-third liter. The water in all these plants abounded with small arthropods of various kinds, among which were entomostracans, and larvae of helodid beetles, mosquitoes, and Chironomidae. These afforded a plentiful supply of food for *Microvelia*."

"The *Aechmea* and the *Hohenbergia* species are widely distributed in Jamaica, occurring often as epiphytes, but also growing directly upon rocks in exposed situations. The *Microvelia*, however, was found in them only in the central and west-central parts of the island, and only at elevations of 2,000 feet or more. *Microvelia laesslei* is not restricted to any one area in the plant, but occurs in the water pockets from the outermost to the innermost whorl of leaves."

"Even the youngest nymphs are strikingly banded with white across the basal segments of the abdomen, simulating the broad white marks on the hemelytra of the fully winged form, or the white wing pads of the micropterous form. No truly apterous individuals have been seen." (Drake and Hussey, 1954: 136).

Since the male of *M. polhemi* n. sp. is fully winged, it may have been caught in a flow of resin exuding from the Dominican amber-tree (*Hymenaea protera*) while it was dispersing by flight between habitats. Although the amber fossil does not provide any direct evidence for the way it lived 15–30 million years ago, its close relationship to a bromeliadicolous species strongly suggests that the small water strider lived in this type of habitat. The reconstruction of the ancient Dominican amber-forest displayed by David Grimaldi in his superb book "Amber—Window to the Past" (Grimaldi, 1996: 101), indicates that the *Hymenaea*-trees harbored epiphytic bromeliads even then. Grimaldi further writes: "Bromeliads were nestled among the branches of the Dominican amber trees themselves. A species of butterfly in Dominican amber (a metalmark) and its caterpillars probably fed upon the bromeliads. Living in the little ponds that accumulate in the center of the bromeliads, no doubt, were mosquitoes, predacious diving beetles, and perhaps even the small frogs found preserved in the amber." (Grimaldi, 1996: 100, 105). It now seems justified to add *M. polhemi* n. sp. to this ancient animal community.

Polhemus and Polhemus (1991) gave an excellent account of the biology and ecology of veliids living in pockets of rain-water in plants belonging to the Bromeliaceae. "The veliid species that we have collected in bromeliads are usually

found between the rather tightly fitting leaves in the center of the plant which trap rainwater in a series of deep pockets, and never occur in bromeliads that lack such water pockets. Among the taxa involved, the *Paravelia* species appear to prefer ground dwelling bromeliad species, while the *Microvelia* species have been taken from both terrestrial and arboreal bromeliads. *Paravelia* and *Microvelia* are in different subfamilies (Veliinae and Microveliinae respectively), so it is clear that adaptation to the bromeliad habitat has occurred on at least two separate occasions. Even so, there are convergent similarities in appearance among all bromeliadiculous species. The macropterous forms possess bright yellow or white spots on the hemelytra, and in the genus *Paravelia* only this morph is known. In *Microvelia* every known bromeliad inhabiting species has in addition either a micropterous or an apterous morph with light markings dorsally in the same position as the light wing spots of the winged morph; in *M. laesslei* these are white micropterous wing pads, in *M. distanti* they are a combination of light colored regions of the integument and silvery pubescent areas, and in *M. ancona* and *M. oaxacana* they are simply bright silvery pubescent areas.” (Polhemus and Polhemus, 1991: 204–205).

The difficulties involved in locating and collecting these insects are vividly described: “We have found that bromeliadiculous veliids are generally not evenly distributed within a patch of bromeliads, but instead tend to aggregate in certain individual plants. While most bromeliads searched will contain only one or two insects, or more commonly none at all, occasional plants are found which contain up to a dozen. In such preferred plants it is often possible to see one or more specimens in a water pocket using a flashlight, and once located they can sometimes be seen even in ambient light, moving about as ghost-like creatures on the water-surface, with only the bright markings visible. The ground dwelling bromeliads that harbor these veliids are often rather large plants which may occur either on the forest floor or on sheer cliffs where collecting is distinctly hazardous. In many instances the plants must be cut off near the base and the leaves peeled away one at a time while each is searched for the veliids, which once exposed run rapidly over the leaf surfaces and attempt to hide in crevices, or move to the dark undersides of the remaining leaves. The most effective way to collect them under such circumstances is by use of an aspirator, with one person dismembering the bromeliad while a second stands ready to suck up the escaping insects.” (Polhemus and Polhemus, 1991: 205).

Distribution and biogeography. The genus *Microvelia* is cosmopolitan but is most species-rich in tropical regions of the World (Andersen, 1982). *Microvelia polhemi* n. sp. is undoubtedly closely related to *M. laesslei* from Jamaica. Most insects known from Dominican amber can also be assigned to taxa which show distinct affinities to species found in the Caribbean and adjacent areas today (Poinar, 1992; Grimaldi *et al.*, 1993; Grimaldi, 1996; Michelsen, 1996). Gerromorphan bugs known from Dominican amber, however, also include forms not included in the extant fauna of these areas. The water strider *Electrobates spinipes* Andersen and Poinar (1992) cannot be classified in any extant subfamily of the Gerridae and has no close relatives in the Caribbean today. Finally, a species belonging to the marine water strider genus *Halovelis* (Veliidae), at present confined to the Indo-West Pacific, was recently described from Dominican amber (Andersen and Poinar, 1998).

Phylogeny and fossil history. Water striders and other semiaquatic bugs (Hemiptera-Heteroptera, Gerromorpha) comprise about 1,600 extant species classified in eight

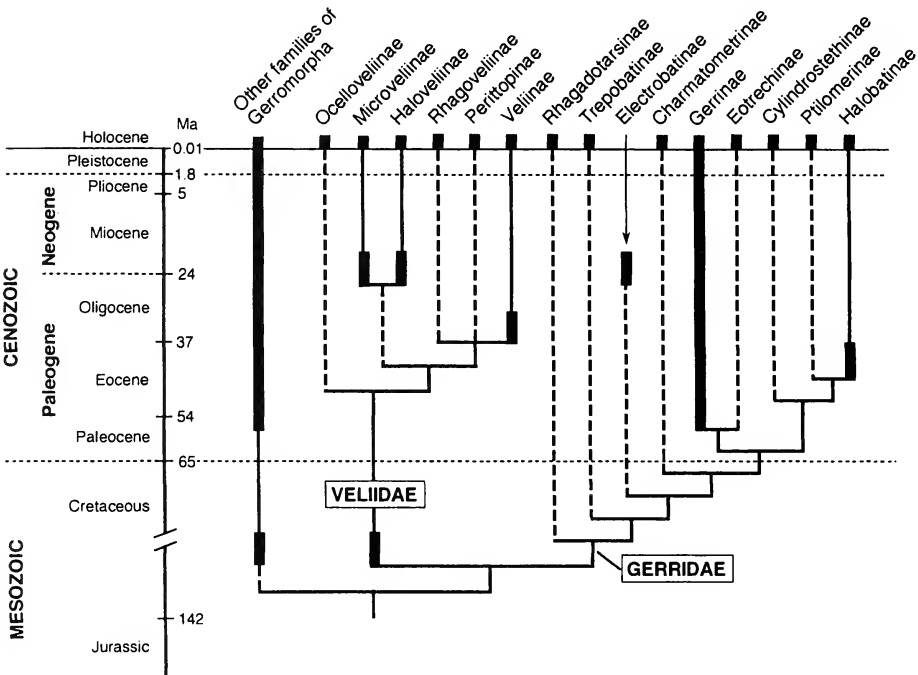


Fig. 4. Phylogenetic tree for the subfamilies of Veliidae and Gerridae (Gerromorpha). Temporal distribution of fossils indicated by heavy branches; unbroken branches denote range extensions inferred from fossils; broken branches denote range extension inferred from sister group relationships. (Modified from Andersen, 1998: fig. 80).

families. The phylogenetic relationships between the gerromorphan families and subfamilies were analyzed and discussed by Andersen (1982). So far, about 30 fossil species belonging to six families have been described or recorded, spanning more than 120 million years of geological history (Andersen, 1998). Although the fossil record of water striders is immensely imperfect, the available fossils provide useful insights into the evolutionary history of the group. By applying cladistic principles and methods, fossil taxa can in most cases be placed in phylogenies (cladograms) together with their extant relatives. Cladograms calibrated against the fossil record yield phylogenetic trees which can be used to estimate minimum divergence time of extant monophyletic groups (clades).

The phylogenetic tree (Fig. 4) depicts the relationships between the subfamilies of the large gerromorphan families Veliidae and Gerridae and the range of fossil forms belonging to these groups. So far, only few fossils have been classified as belonging to the family Veliidae. *Electrovelia baltica* Andersen (1998) from Baltic amber (Eocene/Oligocene) was classified in the Veliinae, setting a minimum age for this subfamily to 40–35 myr. By range extension, the same minimum age can be assigned to the subfamilies Rhagoveliinae and Perittopinae, both without known fossils. So far, *Electrovelia* is the oldest fossil taxon which can be classified in the Veliidae with absolute certainty. However, the family probably originated long before

as indicated by possible veliid fossils from the Lower Cretaceous of Australia (Jell and Duncan, 1986).

Halovelvia electrodominica Andersen and Poinar (1998) was described from Dominican amber (Oligocene/Miocene). When the characters of this species were added to a character data matrix based on extant species, the fossil species assumed a position as the most basal branch of *Halovelvia*. Thus, the minimum age of this genus, as well as of the subfamily Haloveliinae, is 30–15 myr (Fig. 4). Since the subfamily Microveliinae is the sister group of the Haloveliinae, both clades can be assigned the same minimum age (Andersen, 1998: 108). The fossil veliids recorded and described in the present paper suggests that the genus *Microvelia* as well as the subfamily Microveliinae is at least 30–15 myr old.

ACKNOWLEDGMENTS

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LITERATURE CITED

- Andersen, N. M. 1982. The Semiaquatic Bugs (Hemiptera, Gerromorpha). Phylogeny, adaptations, biogeography, and classification. *Entomograph* 3:1–455.
- Andersen, N. M. 1998. Water striders from the Paleogene of Denmark with a review of the fossil record and evolution of semiaquatic bugs (Hemiptera, Gerromorpha). *Det K. danske Videnskab. Selsk. Biol. Skr.* 50:1–157.
- Andersen, N. M. and G. O. Poinar, Jr. 1992. A new water strider genus (Hemiptera, Gerridae) from Dominican amber with evidence of mate guarding in a fossil insect. *Z. zool. Syst. Evolut.-forsch.* 30:256–267.
- Andersen, N. M. and G. O. Poinar, Jr. 1998. A marine water strider (Hemiptera: Veliidae) from Dominican amber. *Entomologica scand.* 29:1–9.
- Drake, C. J. and R. F. Hussey. 1954. Notes on some American Veliidae (Hemiptera), with the description of two new Microvelias from Jamaica. *Fla. Entomol.* 37:133–138.
- Grimaldi, D. 1995. 11. The Age of Dominican Amber. pp. 204–217 in Anderson, K. B. and J. C. Crelling (eds.), *Amber, Resinites, and Fossil Resins*. ACS Symposium Series, 617.
- Grimaldi, D. 1996. *Amber: Window to the Past*. Abrams and American Museum of Natural History, New York.
- Grimaldi, D., C. Michalski and K. Schmidt. 1993. Amber fossil Enicocephalidae (Heteroptera) from the Lower Cretaceous of Lebanon and Oligo-Miocene of the Dominican Republic, with biogeographic analysis of *Enicocephalus*. *Am. Mus. Novit.* 3071:1–30.
- Iturralde-Vinent, M. A. and R. D. E. MacPhee. 1996. Age and paleogeographical origin of Dominican amber. *Science* 273:1850–1852.
- Jell, P. A. and P. M. Duncan. 1986. Invertebrates, mainly insects, from the freshwater, Lower Cretaceous, Koonwarra Fossil Bed (Korumburra Group), South Gippsland, Victoria. *Mem. Assoc. Australas. Palaeontol.* 3:111–205.
- Michelsen, V. 1996. First reliable record of a fossil Anthomyiidae (Diptera), with comments on the definition of recent and fossil clades in phylogenetic classification. *Biol. J. Linn. Soc.* 58:441–451.
- Poinar Jr., G. O. 1992. *Life in Amber*. Stanford University Press, Stanford, California, xiii + 350 pp.

- Polhemus, J. T. and R. S. Copeland. 1996. A new genus of Microveliinae from treeholes in Kenya (Veliidae: Heteroptera). *Tijdschr. Entomol.* 139:73-77.
- Polhemus, J. T. and D. A. Polhemus. 1991. A review of the veliid fauna of bromeliads, with a key and description of a new species (Heteroptera: Veliidae). *J. New York Entomol. Soc.* 99(2):204-216.
- Wesenberg-Lund, C. 1943. *Biologie der Süßwasserinsekten*. Gyldendal & Verlag J. Springer, Copenhagen and Berlin. 682 pp.
- Yang, C.M. and D. Kovac. 1995. A collection of aquatic and semi-aquatic bugs (Insecta: Hemiptera: Gerromorpha and Nepomorpha) from Temengor Forest Reserve, Hulu Perak, Malaysia. *Malay. Nat. J.* 48:287-295.

CURICTA JOHNPOLHEMI (HETEROPTERA: NEPIDAE): A NEW WATERSCORPION SPECIES FROM BRAZIL

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Abstract.—A new species of the New World waterscorpion genus *Curicta* Stål from Brazil is described. This species is dedicated to the eminent heteropterist, John T. Polhemus, in celebration of his 70th birthday.

This new curictan species is dedicated to Dr. John T. Polhemus in celebration of his 70th birthday. Over my ten years of acquaintance with John, I have benefited in more ways than I can count from his mentoring and friendship. I still remember vividly my first visit to his home. My Ph.D. advisor had strongly recommended that I visit with John to discuss ideas for a dissertation project. More than a little bit in awe of Polhemus, I had spent the weeks prior to the visit studying the literature on my chosen group, the waterscorpions. Upon arrival in Englewood, John and his wife Irma treated me to pleasant conversation and a relaxing beer on their back porch. Just when the beer was beginning to have an effect, John announced it was time to get to work. We descended into his basement museum/library where I was set down at a microscope and a waterscorpion was placed in front of me. “What is it?” asked John. Fortunately, my blood alcohol level was high enough at that point so that I didn’t freeze up in a flight-fright response. Instead, I spent a minute or so scanning the insect and then brazenly announced that it looked like a *Telmatotrephes* species. (Now, I had never seen a *Telmatotrephes* waterscorpion, which are rather rare in collections, but, in my “relaxed” state, the bug before me seemed to resemble the pictures and descriptions of *Telmatotrephes* I had studied prior to my visit.) “Exactly!” said John, “It looks like a *Telmatotrephes* but it isn’t! And I want you to find what it *really* is!” “Sure, I can do that,” I replied after taking another long swig on my beer. Thus, began my career as an heteropterist. During that same visit John launched me on my dissertation project, a revision of *Curicta*, and then he nurtured me through that effort with patience and a penetrating, yet kindly, criticism of my work. In subsequent years, John has continued to be unfailingly supportive of all my efforts through generous specimen loans and forays deep into his library to solve knotty nomenclatural problems. I know that John is similarly helpful to many, many other heteropterists around the world. How he manages to do so and, at the same time, maintain his oftentimes frenetic travel/collecting schedule and phenomenal productivity is nothing short of amazing.

In short, whatever success I have achieved as an heteropterist I owe in large part to John Polhemus. And while I know that I will never be able to match his productivity, I hope that I will never forget to emulate his generosity and kindness.

METHODS AND MATERIALS

This description is templated from the species descriptions in Keffer's 1996 revision of *Curicta*. The reader is also referred to that revision for an extensive discussion of characters, a key to species, and a cladistic analysis of the genus. Illustrations were produced with a camera lucida. All measurements given are in mm.

***Curicta johnpolhemi*, new species**

Figs. 1-4

Description. Measurements. Holotype female (no other specimens known): length, 16.1; profemoral length, 5.0; siphons, 8.5.

Color: Dark brown. Pronotum and hemelytra mottled with lighter areas. Prosternum dark brown medially, lighter laterally. Meso- and metasterna light brown, mottled with darker areas. Abdominal dorsum reddish. Abdominal sterna, including operculum, dark brown laterally, mottled dark and light brown medially. Abdominal parasterna reddish brown with light brown mottling. Abdominal laterotergites dark brown with lighter mottling. Protibia and tarsus yellow. Profemur dark brown with lighter mottling. Meso- and metathoracic legs dark brown with lighter mottling; tibiae and tarsi with distal dark brown annulus.

Structural characteristics. Body elongate (Fig. 1): length $4.6\times$ maximum width. Eye width $0.5\times$ interocular distance. Vertex broadly convex; without median longitudinal carina. Lobe of antennal segment 2 less than $0.5\times$ length of 3.

Pronotum elongate; lateral length $1.4\times$ posterior width. Lateral margins parallel midway, divergent posteriorly and anteriorly. Transverse sulcus incomplete. Median longitudinal sulcus very shallow; obsolescent in posterior $\frac{2}{3}$'s. Median longitudinal ridges rounded. Lateral longitudinal sulci shallow. Lateral longitudinal ridges rounded. Granulations in midline sulcus and on humeral lobes. Posteroventral extension of pronotum meet in ventral midline at junction of pro- and mesosterna.

Scutellum width less than length. Trident pattern indistinct; longitudinal section of lateral prongs appears convex medially.

Hemelytra lateral margins subparallel from apex of scutellum to base of membranes, narrower anteriorly and posteriorly. Metathoracic wings fully developed.

Prominent carinae on bilateral plates of last abdominal tergum form dome-like structure in distal $\frac{2}{3}$'s which has its greatest elevation along the midline (Fig. 2); tomentose distally.

Prosternum in lateral view not swollen. Mesosternum without midline groove; no elevated carinae or bands of hair lateral to midline. Parasterna of last abdominal segment without distal processes (Fig. 3). Posterior margin of operculum extends beyond distal margin of parasterna.

Procoxae $0.47\times$ profemoral length. Two profemoral teeth; distance from base of femur to tip of anteroventral profemoral tooth $0.47\times$ total profemoral length (Fig. 4). Profemur moderately arched beyond profemoral teeth. Single row of tubercles in profemoral sulcus evident in distal $\frac{2}{3}$'s; no teeth in sulcus distally.

Metafemora when extended posteriorly just reach anterior margin of sternum 6.

Female genitalia: Gp2 arched dorsomedially.

Discussion. The prominent carinae of the last abdominal tergum are diagnostic for this species. *Curicta scorpio* Stål and *C. pronotata* Kuitert, both Central American

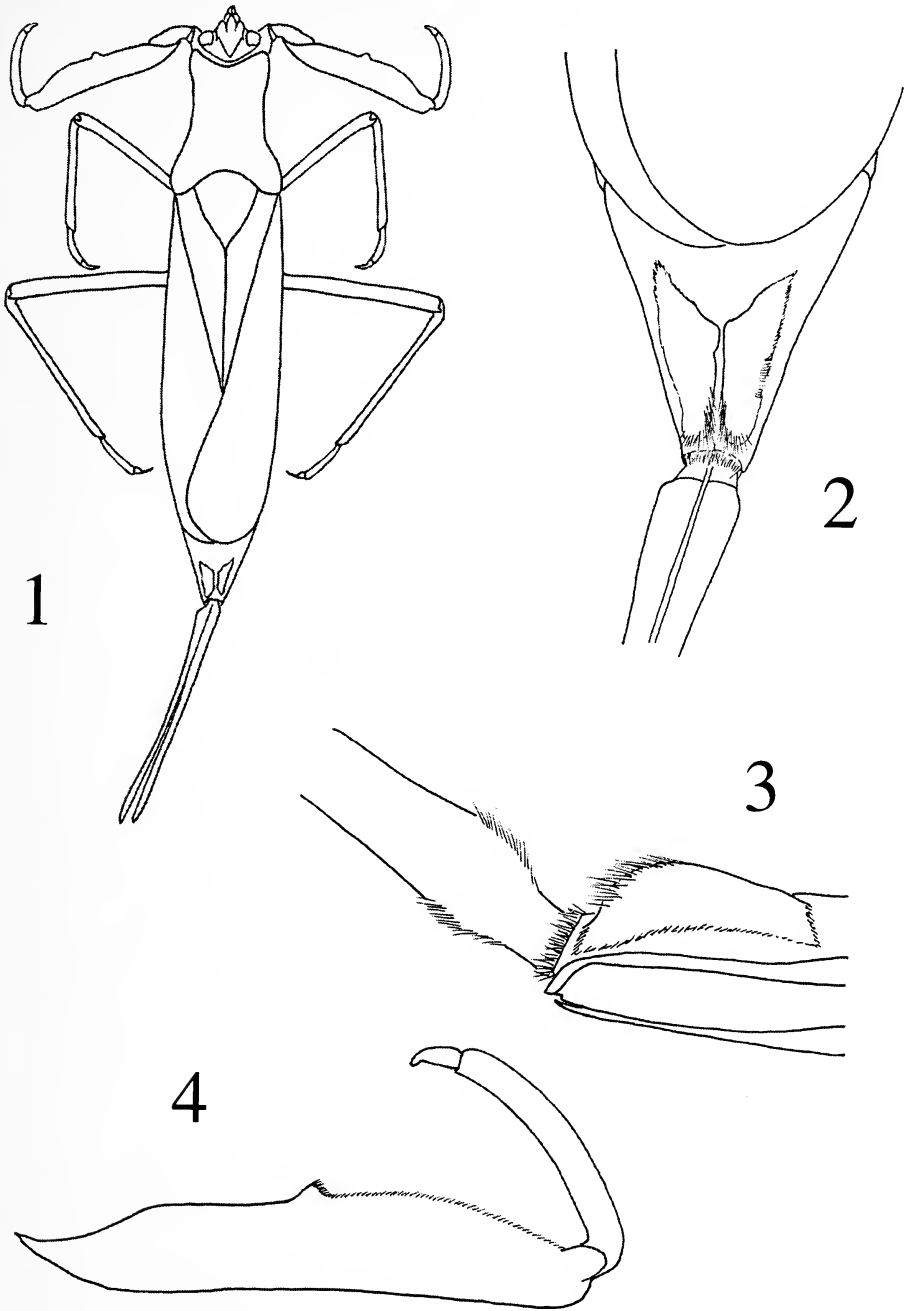


Fig. 1-4. *Curicta johnpolhemi*, n.sp. 1. Dorsal habitus. 2. Last abdominal segment (dorsal view). 3. Last abdominal segment (lateral view). 4. Profemur, tibia, tarsus (anterior view).

species, also have prominent carinae on the last abdominal tergum but their carinae are paramedial and therefore do not together form a dome-like structure as occurs in *C. johnpolhemi*. *Curicta bilobata* Kuitert, a South American species, was originally diagnosed, in part, by two large plates on the dorsum of the last abdominal. However, upon examination of the male holotype, and only known specimen for the species, Keffer (1996) discovered that these "plates" were actually the result of deformation of the last abdominal tergum by a partially extended phallus. *Curicta bilobata* is readily distinguished from *C. johnpolhemi* by having only one profemoral tooth.

In South America, *C. johnpolhemi* is among the smallest curictans. Only *C. pelleranoi* DeCarlo and *C. bonaerensis* (Berg) have comparably sized females but these two species have only one profemoral tooth while *C. johnpolhemi* has two. By general facies, *C. johnpolhemi* might initially be mistaken for one of two other South American species, albeit a very small example of each: *C. carinata* Kuitert and *C. granulosa* DeCarlo. Both of these species, however, have a well defined carina on the vertex, and either carinae (*carinata*) or dense bands of hair (*granulosa*) on the mesosternum. *Curicta johnpolhemi* is without either a carina on the vertex or carinae/bands of hair on the mesosternum.

Three characters indicate that this new species is most closely allied with the Central and North American species, *C. scorpio*: carinae on the last abdominal terga, proximal profemoral teeth, and the absence of processes on the last abdominal parasterna. As already mentioned two species, *C. scorpio* and *C. pronotata*, have abdominal carinae. Several curictans have proximal femoral teeth: *C. scorpio*, *C. pronotata*, *C. hungerfordi* Kuitert, and *C. peruviana* Kuitert and some, but not all, specimens of *C. granulosa* DeCarlo, and *C. carinata* Kuitert. Only *C. scorpio* lacks parasternal processes.

Distribution. Brazil: Minas Gerais.

Type. Holotype, female, BRAZIL, **Minas Gerais**: 14 km NE Diamantina, Brazil Rd. 367, 18°10.08'S, 43°33.57'W, 8.xi.97, T. J. Henry. Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

LITERATURE CITED

- Keffer, S. L. 1996. Systematics of the New World waterscorpion genus *Curicta* Stål (Heteroptera: Nepidae). J. New York Entomol. Soc. 104(3-4):117-215.

**PROMIORRHYNCHUS POLHEMUSI NEW GENUS, NEW SPECIES,
FROM MEXICO (HETEROPTERA: ARADIDAE)**

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Abstract.—The micropterous *Promiorrhynchus polhemusi* new genus, new species from Veracruz, Mexico, is described and figured. The new taxon is related to but distinguished by a combination of characters from the macropterous Neotropical genera *Miorrhynchus* Usinger & Matsuda, *Rhynchomirus* Kormilev and *Saileriessa* Usinger & Matsuda. The only micropterous Neotropical genera known to date are *Delnocoris* Kormilev and *Kelaino* Kormilev, which show a similar alary reduction but are distinct different taxa.

Key Words: Heteroptera, Aradidae, Mezirinae, *Promiorrhynchus polhemusi* new genus, new species, Mexico.

The subfamily Mezirinae is represented in the Neotropical region so far by 42 genera and more than 300 species (Kormilev and Froeschner, 1987). While eleven of those genera are apterous, only the two monotypic genera *Delnocoris* Kormilev from Costa Rica and *Kelaino* Kormilev from Colombia are micropterous. This reduced alary condition occurs also in very few species of generally macropterous genera such as *Pictinus* Stål (2 sp.) and *Notapictinus* Usinger and Matsuda (1 sp.), all of them only known from Brazil.

Discovery of a micropterous species from Southeastern Mexico, which shares some characters of related macropterous genera, but does not fit into one of them (Drake and Kormilev, 1958; Usinger and Matsuda, 1959; Kormilev, 1976), made it necessary to assign it to a new genus, which is described below.

Measurements are taken with a micrometer eyepiece 40 units = 1 mm.

Abbreviations for depositories of types: CEHI, Collection Ernst Heiss, Innsbruck, Austria; UNAM, Universidad Nacional Autónoma de México, Instituto de Biología; USNM, National Museum of Natural History, Smithsonian Institution, Washington D.C.

Promiorrhynchus, new genus

Type species. *Promiorrhynchus polhemusi*, new species.

Diagnosis. Distinguished from all macropterous genera of similar habitus (*Miorrhynchus* with 14 species distributed from Paraguay to Panama; *Rhynchomirus*, one species from Peru; *Saileriessa*, one species from Panama) by a combination of characters: antennae 3.3× as long as width of head across eyes, postocular portion of head with a prominent tubercle, pronotum with rounded anterolateral angles and a deep transverse sulcus at middle, scutellum rounded, hemelytra reduced to oblique wing pads, spiracles II–IV ventral, V–VIII lateral and visible from above, vestiture of body and appendages with yellow curled hairs.

Distribution. Mexico.

Description. Small, about 5 mm, micropterous. Body elongate, attenuated anteriorly. Surface matte, granulate, beset with stiff erect, apically mostly curved hairs on raised portions of body and on appendages.

Head. Longer than wide across eyes. Genae slightly projecting beyond clypeus, beset with tubercles bearing stiff hairs. Antenniferous tubercles shorter than clypeus, straight, with blunt apices. Antennae long and slender, $3.3\times$ as long as width of head. Eyes ovate, partially inserted. Postocular portion straight and long, posteriorly with a lateral prominent tubercle bearing stiff hairs, then strongly converging to collar. Rostrum shorter than head, arising from a slitlike atrium, rostral groove closed posteriorly.

Pronotum. Wider than long, anterolateral angles broadly rounded, collar distinct. Disk medially with a deep transverse impression, anterior portion with sublateral longitudinal elevations, posterior portion coarsely granulate. **Scutellum.** Wider than long, rounded, with a median longitudinal elevation, margins carinate. **Hemelytra.** Corium reduced to oblique wingpads, membrane and hind wings absent.

Abdomen. Raised first and lower second mediotergite (Mtg) exposed, separated by a transverse suture. Tergal plate with Mtg III–VI fused, moderately elevated medially. Dorsal laterotergites (Dltg) somewhat reflexed laterally, with increasingly producing posterolateral angles. Dltg II + III fused and badly delimited by an arcuate impression dorsally.

Ventral side. Pro-, meso- and metasternum depressed medially, marked by distinct transverse sutures. Metathoracic scent gland canals forming an oblique elevation, which is visible from above. Spiracles II–IV ventral, V sublateral on ventral laterotergite (Vltg) but visible from above, VI–VIII lateral and visible from above.

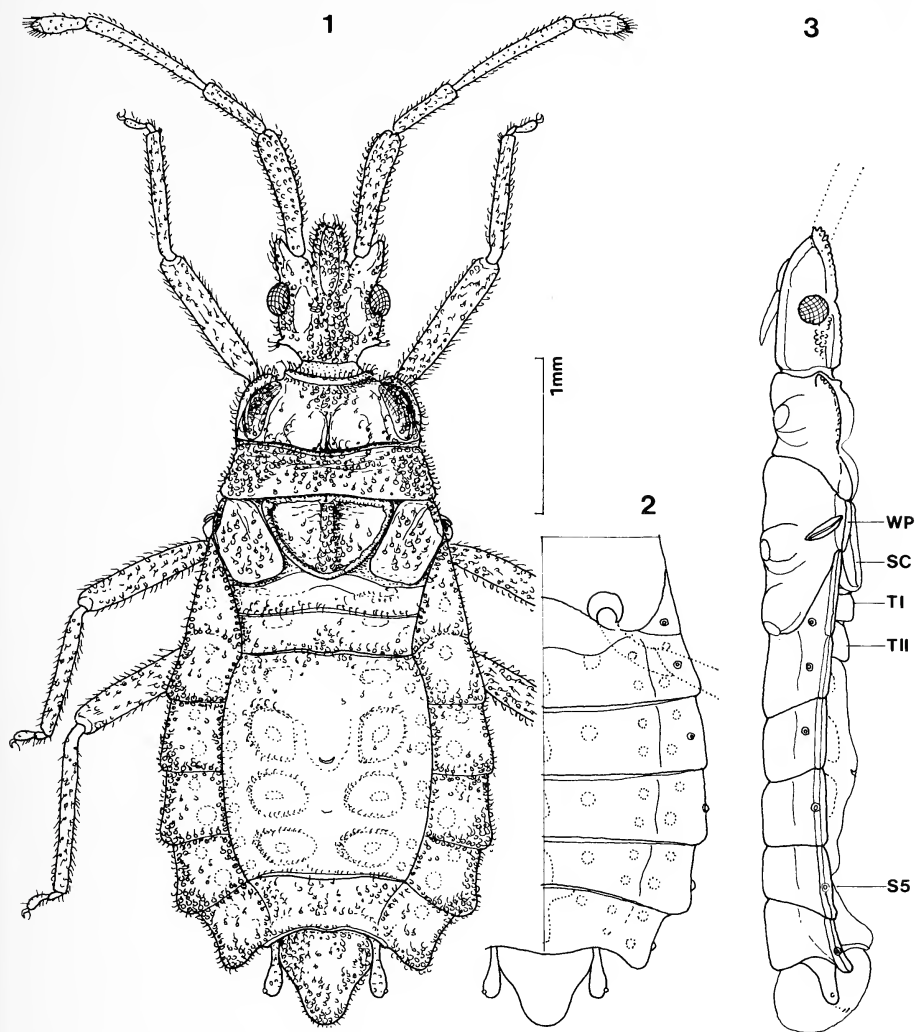
Legs. Long and slender, femora and tibiae cylindrical, claws with curved pulvilli.

Etymology. Named for its resemblance to the macropterous genus *Miorrhynchus*. Gender masculine.

Discussion. The new genus resembles the genera *Miorrhynchus*, *Rhynchomirus* and *Saileriessa* in habitus, having a slender elongate body, long legs and antennae with third segment longest, but all of them are only known from macropterous and one brachypterous species.

From the widespread *Miorrhynchus*, the only other genus with curled hairs, *Pro-miorrhynchus* is distinguished at once by spiracles V–VIII lateral (VI–VIII lateral in *Miorrhynchus*), genae slightly longer than clypeus (not longer in *Miorrhynchus*) and postocular portion of head with a prominent lateral tubercle, which is lacking in *Miorrhynchus*. *Rhynchomirus* shares the same long antennae and spiracles V–VIII are also lateral, but the new genus has curled hairs and the pronotum has a transverse impression, both characters lacking in *Rhynchomirus*, the scutellum is rounded and not triangular as in *Rhynchomirus*. *Saileriessa* has also spiracles V–VIII lateral as *Promiorrhynchus*, but shows a smooth surface and lacks also the curled hairs, the anterolateral margin of the pronotum is angular not rounded as in *Promiorrhynchus* and the head is much shorter than the pronotum (1.1 times in new genus).

The micropterous genus *Delnocoris* has long lateral expansions on pro- and mesonotum and a long posteriorly constricted head. *Kelaino*, the second micropterous genus, has a transverse head and pronotum and shorter antennae. Both are seemingly not related to *Promiorrhynchus*.



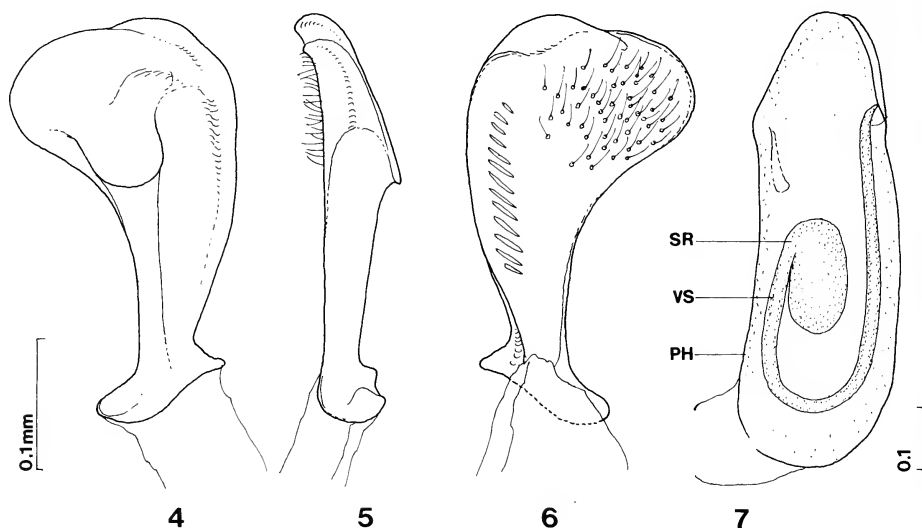
Figs. 1–3. *Promiorrhynchus polhemusi* new genus, new species. 1. Holotype male, habitus dorsal. 2. Ventral side. 3. Lateral view. Abbreviations: SC—scutellum; S5—spiracle of Vltg V; T I—mediotergite I; T II—mediotergite II; WP—wingpad.

***Promiorrhynchus polhemusi*, new species**

Figs. 1–7

Types. Holotype, ♂, MEXICO, Veracruz, Catemaco — Los Tuxtlas, 18.vii.1992, S. Ebner (USNM). Paratypes: 4 males, same data as holotype (CEHI, UNAM).

In recognition of their kind assistance in entomological matters, the holotype is presented to the National Museum, Smithsonian Institution, Washington D.C. and a paratype to Universidad Nacional Autónoma de México, Instituto de Biología.



Figs. 4-7. *Promiorrhynchus polhemusi* new genus, new species. 4-6. Right paramere in different positions. 7. Aedeagus lateral. Abbreviations: PH—phallosoma; SR—sperm reservoir; VS—vesica.

Description. Male, micropterous, habitus as Fig. 1.

Head. Longer than wide across eyes (35:31); genae slightly producing beyond apex of clypeus, their apices with tubercles bearing stiff hairs. Antenniferous tubercles with subparallel lateral margins, apices blunt, shorter than clypeus. Antennae slender, 3.3 times as long as width of head across eyes (102:31), first segment long and thickest, second thinner and shorter, third thin and longest, fourth barrelshaped with pilose apex. Relative length of segments I:II:III:IV = 33:19:35:15. Eyes ovate. Vertex raised medially with 2 (1 + 1) ovate depressions laterad. Postocular portion straight with a laterally projecting prominent tubercle, which is beset with long hairs. Rostrum short, not reaching closed elevated border of rostral groove.

Pronotum. Subrectangular, shorter than wide (30:51). Anterior portion with subparallel lateral margins, broadly rounded and reflexed anterolaterally. Collar ring-like. Disk with 2 (1 + 1) sublateral ridges, surface inbetween smooth with a longitudinal groove, which is connected to the transverse sulcus dividing the pronotal disk. Posterior portion with coarse granulation which is more dense at humeri.

Scutellum. Wider than long (21:33), of semicircular shape. Anterior and lateral margins elevated. Disk with a longitudinal granulate elevation medially and coarse tubercles laterad.

Hemelytra. Corium reduced to subrectangular wingpads, not covering completely the metanotum. Surface coarsely granulate.

Abdomen. Elongate, ovate, lateral margins of Dltg III to VII with rounded, increasingly producing posterolateral angles. Dltg II and III fused, but marked by an arcuate depression dorsally. Mtg I + II exposed, their posterior margin raised. Tergal plate with a median elevation, highest on Mtg IV. Metathoracal scent gland canals visible from above as split, rounded elevations.

Venter. Mediosternites (Mst) II + III fused, medially marked by a curved suture. Mst III to VII separated by deep transverse, from ventral laterotergites by thin longitudinal sulci. Spiracles II to IV ventral, close to lateral margin, V sublateral and visible from above, VI to VIII lateral and also visible from above (Fig. 2).

Legs. Long and slender, femora and tibiae cylindrical with coarse granulation and stiff hairs.

Male genitalic structures. Pygophore large, pyriform with rounded apex. Parategites VIII club-shaped, reaching $\frac{2}{3}$ of pygophore. Parameres blade-like, the inner face with a file like row of 12–14 short carinae and stiff hairs (Figs. 4–6). Aedeagus with anteriorly attenuated and split phallosoma, vesica long and curved (Fig. 7).

Measurements. Holotype. Length 5.1 mm, length of antennae 2.55 mm, width of abdomen across Dltg IV 2.1 mm. Length of paratypes 5.1–5.2 mm.

Etymology. It is a pleasure to dedicate this interesting species to my friend John T. Polhemus on the occasion of his 70th birthday.

ACKNOWLEDGMENTS

I wish to thank Dan A. Polhemus for the invitation to contribute to this festschrift volume and Randall T. Schuh for suggestions improving this paper.

LITERATURE CITED

- Drake, C. J. and N. A. Kormilev. 1958. Concerning the apterous Aradidae of the Americas (Hemiptera). *Ann. Entomol. Soc. Amer.* 51:241–247.
- Kormilev, N. A., 1976. A new genus and seven new species of the Neotropical Aradidae (Hemiptera, Heteroptera). *Rev. Bras. Biol.* 36:735–743.
- Kormilev, N. A. and R. C. Froeschner. 1987. Flat bugs of the world, a synonymic list (Hemiptera: Aradidae). *Entomography* 5:1–246.
- Usinger, R. L. and R. Matsuda. 1959. *Classification of the Aradidae (Hemiptera-Heteroptera)*. British Museum, London, vii + 410 pp., 4 pls.

ASTELIAMIRIS, A NEW GENUS OF STENODEMINI FROM THE HAWAIIAN ISLANDS (HETEROPTERA: MIRIDAE)

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Abstract.—*Asteliamiris johnpolhemi*, a new genus and new species of stenodemine Miridae, is described from the island of Maui, in the Hawaiian Islands. Unlike most members of the Stenodemini which breed on grasses or sedges, both nymphal and adult stages of *A. johnpolhemi* are associated with *Astelia menziesiana* Smith, a member of the Liliaceae. Dorsal habitus photographs, scanning electron micrographs of the head, scent gland efferent system, and pretarsus, illustrations of the male and female genitalia, and a distribution map are provided.

Unusual habitat shifts are a well known phenomenon in species occurring on oceanic islands. Among the Heteroptera of Hawaii, for example, one finds members of the Saldidae which have moved from a typical riparian existence into arboreal habitats (Cobben, 1980), species of Nabidae which have moved from typical arboreal niches into riparian habitats (Polhemus, 1999), and species of Lygaeidae which have adapted to life at the margins of alpine snowfields (Polhemus, 1998). To this list of ecological divergences may now be added a new genus of Hawaiian stenodemine Miridae which, instead of feeding on grasses like nearly all other members of the tribe, occurs on *Astelia*, a plant belonging to the family Liliaceae.

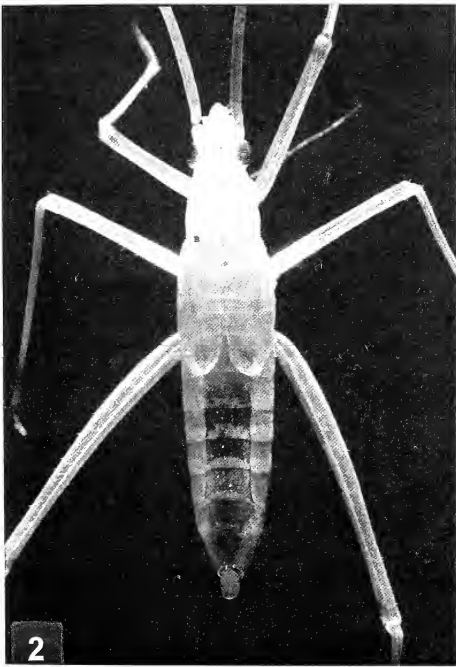
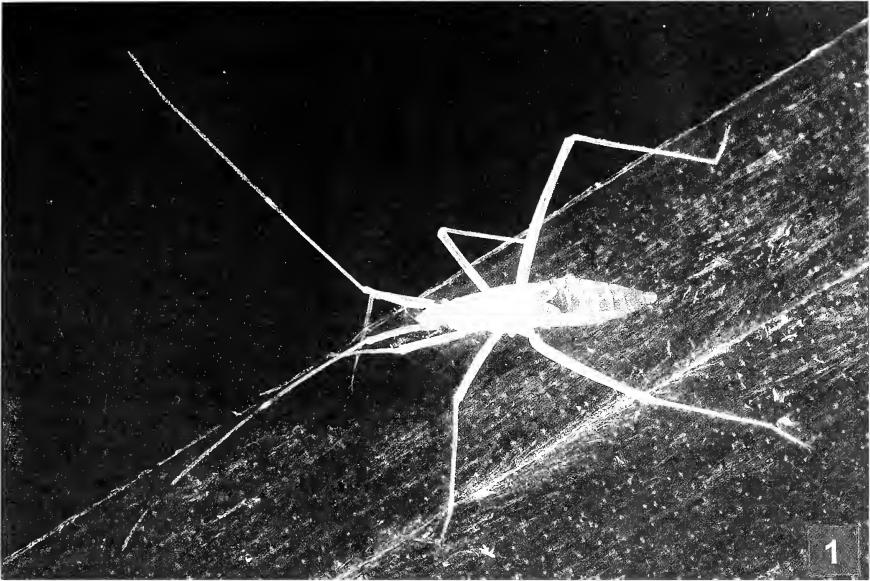
The existence of this odd insect was initially brought to the second author's attention by Betsy Gagné, of the State of Hawaii's Natural Area Reserves System, whose deceased husband Wayne Gagné had discovered the first specimens in Kipahulu Valley, on eastern Maui. Like many of Gagné's inspired entomological discoveries, this one remained vaguely recalled and poorly investigated following his untimely death in 1988, and it was not until 1998 that an expedition was mounted to Kipahulu Valley specifically to search for what had by that time come to be known as the "*Astelia* bug." This foray was successful and, in combination with a few additional specimens captured during concurrent surveys along the northern face of Haleakala, has finally permitted description and illustration of this unique Hawaiian mirid.

All measurement are given in millimeters.

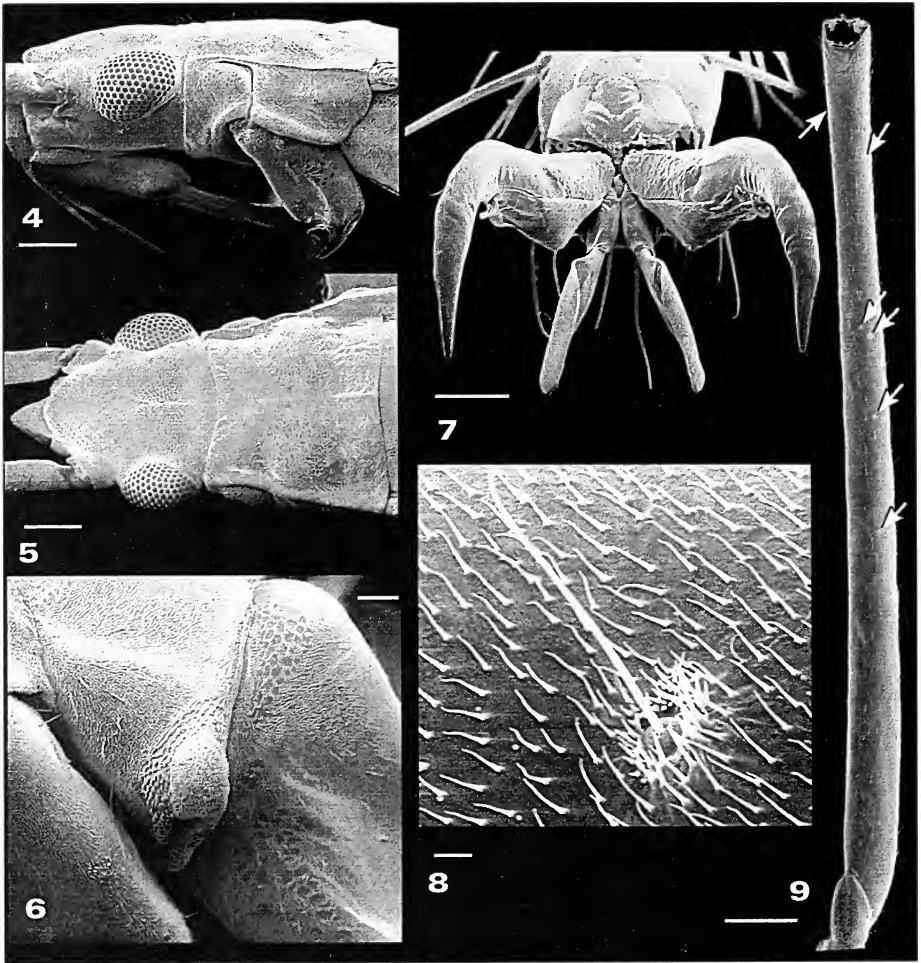
Asteliamiris, new genus

Figs. 1–17, 19

Diagnosis. Distinguished from other stenodemine genera by the following combination of characters: pretarsus with minute pulvillus; head with medial longitudinal



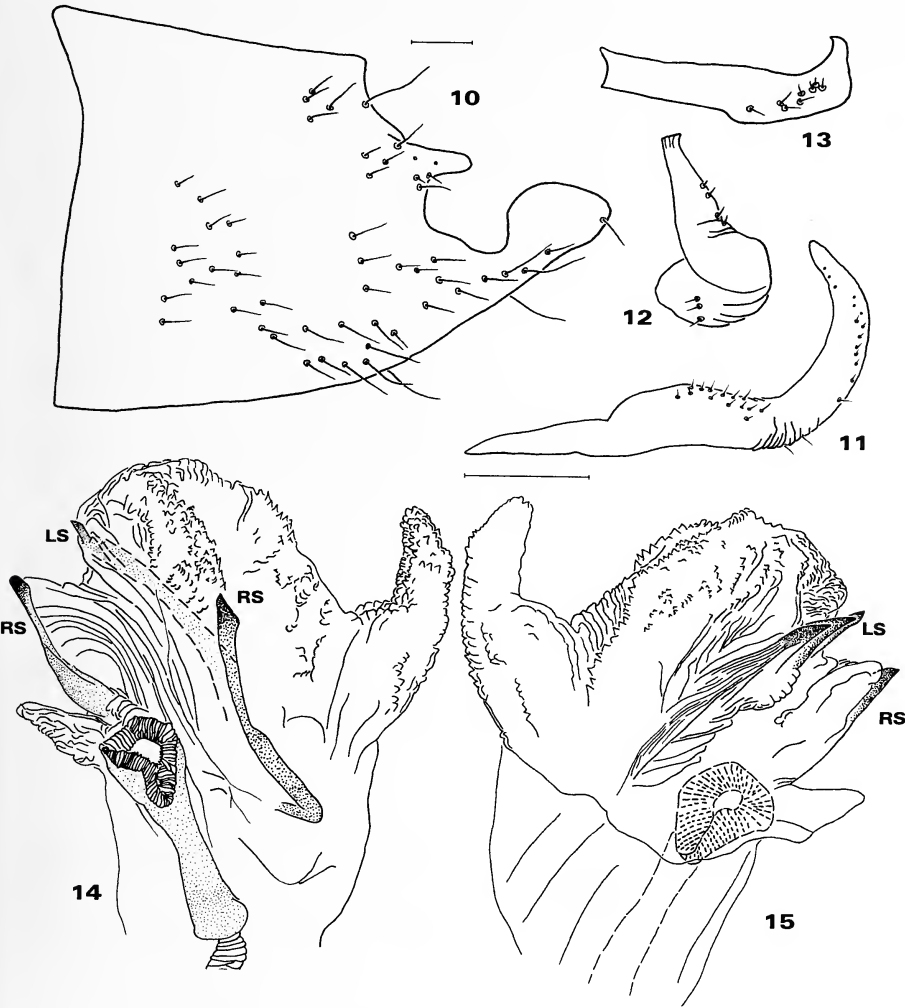
Figs. 1–3. 1. Habitus photograph of *Asteliamiris johnpolhemi* (photo courtesy Bill Mull). 2. Photograph of *A. johnpolhemi*, dorsal view (photo courtesy Bill Mull). 3. Type locality of *Asteliamiris johnpolhemi* on Mauka Ridge, Haleakala National Park. Note the clumps of *Astelia menziesiana* below an overstory of *Metrosideros polymorpha*.



Figs 4-9. Photomicrographs of *Asteliamiris johnpolhemi*. 4. Head and propleuron, lateral view, scale bar = 200 μ . 5. Head, pronotum, dorsal view, scale bar = 200 μ . 6. Ostiolar peritreme, lateral view, scale bar = 50 μ . 7. Pretarsus; apical view, scale bar = 20 μ . 8. Detail of penultimate distal metafemoral trichobothrium, scale bar = 5 μ . 9. Metafemur, ventral view, arrows denote trichobothria; scale bar = 300 μ .

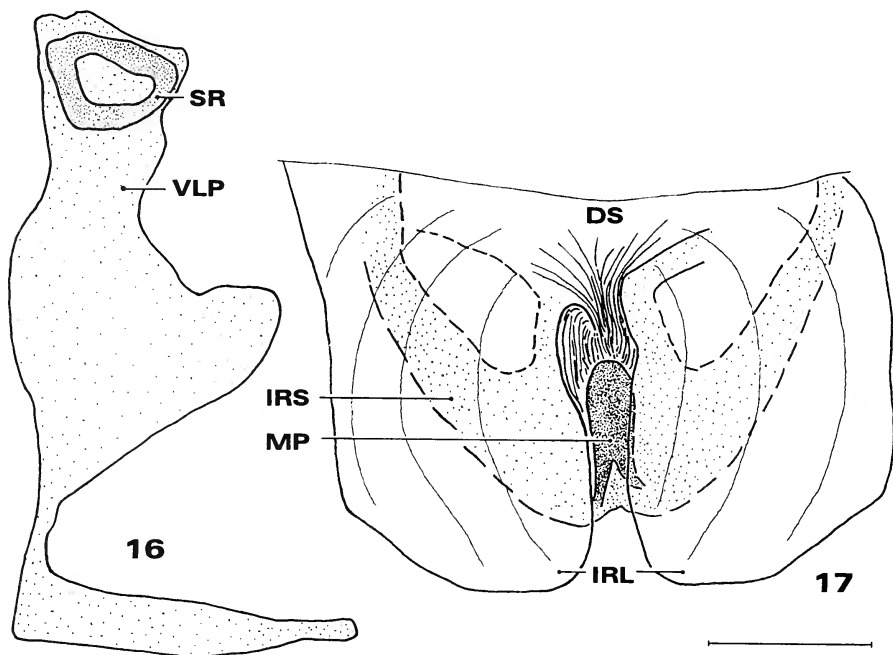
sulcus on frons; eyes not strongly projecting, broadly joined to head; obscurely rugulopunctate dorsum; short setae on antennal segment 2 and metatibia; length of antennal segment 1 less than combined length of the head and pronotum; absence of long dark setae on base of antennal segment 2; brachypterous hemelytra; length of antenna twice as long as body; long legs; maxillary plate with obvious blunt tubercle on anterior margin; and genitalia, especially the vesica with a three-pointed lobal sclerite and the obscure sclerotized rings.

Description. *Adult male.* (Figs. 1, 2). *Dorsal aspect:* moderate body size; head,



Figs. 10–15. *Asteliamiris johnpolhemi*, male genitalia. 10. Genital capsule, lateral view. 11. Left paramere, lateral view. 12. Left paramere, apical view. 13. Right paramere, lateral view. 14, 15. Vesica; LS, lobal sclerite; RS, ribbon-like strap. 14. Dorsal view. 15. Ventral view. Scale bar = 0.1 mm.

pronotum, mesoscutum, and scutellum smooth; hemelytra smoothly rugulopunctate. *Vestiture*: dorsum with sparsely distributed, short, suberect, pale simple setae (best examined in lateral view); antennal segments with moderately and uniformly distributed, suberect, pale, simple setae with length slightly longer than setae on dorsum; segment 1 without bristle-like setae. Legs with moderately densely distributed, suberect simple setae with length slightly shorter than width of metatibia, color slightly darker than antennal setae; interior surface of metatibia without minute, stout, black



Figs. 16, 17. *Asteliamiris johnpolhemi*, female genitalia. 16. Left sclerotized ring and ventral labiate plate, dorsal view; SR, sclerotized ring; VLP, ventral labiate plate. 17. Posterior wall, ventral view; DS, dorsal structure; IRL, inter-ramal lobe; IRS, inter-ramal sclerite; MP, median process. Scale bar = 0.1 mm.

spicules; tibiae without bristle-like setae. *Head* (Figs. 4, 5): acutely triangular in dorsal view, subrectangular in lateral view; eye relatively small, subovate, slightly protruding from lateral margin of head in dorsal view, anterior margin emarginate, removed from antennal socket and anterior margin of pronotum by distance slightly less than basal diameter of antennal segment 1; basal carina of vertex broadly and slightly elevated; frons with moderately deep longitudinal sulcus; anterior margin of frons elevated dorsal to, but not anterior to base of clypeus, even with anterior margin of maxillary and mandibular plates, and slightly anterior to antennal socket; clypeus protuberant, slightly pointed; maxillary plate with obvious blunt tubercle on anterior margin; antennal socket situated dorsal to ventral margin of eye, anteroventral margin with smaller tubercle; width of gena twice diameter of antennal segment 1; buccula short; buccal cavity small reaching middle of head in lateral view; labium reaching apex of mesocoxa; segment 1 just reaching base of head. *Antenna*: longer than twice length of body; segment 1 twice as long as length of head; 2 thinner than 1 and longer than 3, 3 longer than 4; 3 and 4 filamentous. *Pronotum* (Figs. 4, 5): subquadrate, with indistinct anterior and posterior lobes, slightly convex, lateral margin almost straight, lateral margin, including region dorsal to coxal cleft, carinate; propisternum visible in dorsal view; calli indistinct, not reaching lateral margin of pronotum; collar flattened, with distinct posterior sulcus; coxal incisure deep, reach-

ing under lateral carina; Ostiolar peritremal disk (Fig. 6) with small rounded prominence and small evaporative surface. *Mesoscutum* and *scutellum*: confluent, flattened, except for somewhat raised dark apex. *Hemelytra*: brachypterous, without cuneus or membrane, only claval vein present; apex narrowly rounded; length equal to combined length of head, pronotum, and scutellum; embolium relatively wide, carinate laterally; hind wing absent. *Venter*: uniformly pale yellowish green with sparsely distributed, suberect, pale simple setae. *Legs*: long, rounded, narrow throughout, except metafemora slightly thickened at base; metatibia longer than metafemora and abdomen, slightly shorter than antennal segment 2; apex of protibia slightly flattened, with longer mesially directed setae and minute, apical, comb-like spinules; metatarsus with segment 1 longer than combined length of segments 2 and 3; mesofemora with six trichobothria, metafemora with six trichobothria (Figs. 8, 9). *Claws* (Fig. 7): with relatively moderate length, strongly curved; paraempodium lamellate, diverging distally; pulvillus minute, situated just mesal to bend in claw. *Genitalia*: Genital capsule: elongate-conical, with narrow, laterally deflected tubercle dorsal to left paramere insertion; posteroventral portion of capsule produced (Fig. 10). Left paramere: small, sensory lobe elongate, slightly produced above arm; arm short; shaft short thick at base, abruptly narrowed distally; apex recurved, pointed; surface with short setae (Figs. 11, 12). Right paramere: small, linear, slightly expanded medially; abruptly constricted distally to narrowed ventrally directed pointed apex, surface with short setae (Fig. 13). Vesica: ductus seminis narrow throughout; secondary gonopore with complete, moderately large aperture with deep ventral cleft; membrane surface deeply wrinkled, with one large, somewhat rounded, central lobe and several small, narrow lateral lobes; back of central lobe with prominent lobal sclerite with three spine-like lobes; base of vesica with obscure ribbon-like strap attached to back of base of ductus seminis, extending dorsal and curving around bases of faint, thin sclerites forming two socket-like structures left and right of secondary gonopore (Figs. 14, 15).

Female. Similar to male in all features except coloration. *Genitalia*: Sclerotized rings: small, D-shaped, aperture obscure, apparently open (Fig. 16). Ventral labiate plate: large, present behind rings, barely extending medially, not spanning rings (Fig. 16). Posterior wall (Fig. 17): inter-ramal sclerite faint or entirely membranous; median process well sclerotized, without projecting dorsal or posterior sections, but with two small basal projections; dorsal structure not sac-like, broadly open anteriorly, and flattened dorsally; inter-ramal lobes present as two large, widely separated lobes, with apices directed ventrally and surpassing ventral margin of sclerite, obscuring entire sclerite.

Etymology. Named for the apparent strict host association of the included species with *Astelia menziesiana* Smith (Liliaceae), and from *miris*, pertaining to the family Miridae.

Type species. *Asteliamiris johnpolhemi* Schwartz and Polhemus.

Discussion. *Asteliamiris* will key with difficulty to *Trigonotylus* in the key to adult stenodemine genera of the World in Schwartz (1987), but the brachypterous hemelytra, long antenna and legs, genitalia, and habitat will easily separate the new genus from species of this cosmopolitan grass-feeding genus. Only the type species, an apparent Maui endemic, is currently placed in this genus. *Asteliamiris* nicely fits in the *Trigonotylus*-group of genera, which comprises *Chaetodus* Eyles, *Dolichomiris*



Fig. 18. Habitus photograph of *Kuscheliana masatierrensis* Carvalho on *Rumohra berteriana* (Colla) Rodr.

Reuter, *Megaloceroea* Fieber, *Schoutedenomiris* Carvalho, and *Trigonotylus* Fieber (Schwartz, 1987); endemic species of the latter genus are also present in Hawaii, but whether they constitute the ancestral stock from which *Asteliamiris* was derived is uncertain. The following synapomorphic characters support the group: dorsal surface without punctures; genital segment of male with tubercle(s) present dorsal to the left and sometimes the right paramere; sensory lobe of left paramere only slightly projecting above surface of arm; vesica with basal processes sometimes developed into socket-like structures; and the inter-ramal sclerite with an obsolete dorsal structure and large inter-ramal lobes with widely separated apices which converge mesially and surpass the ventral margin of the sclerite.

Asteliamiris is only the second recorded genus of stenodemine which exploits non-grass or sedge host plants (Schuh, 1995). Carvalho (1952) reported that *Kuscheliana masatierrensis* Carvalho lives among ferns (*Rumohra berteriana* (Colla) Rodr. [Davalliaceae]) in the dark and damp recesses of the forest. This unrelated genus, endemic to the Juan Fernandez Islands, exhibits similar morphology, i.e., brachyptery, long legs and antennae (Fig. 18), to the Maui endemic *Asteliamiris*. These shifts to non-grass hosts and convergent morphologies suggest that there may be a typical and predictable suite of responses by stenodemines which manage to colonize isolated oceanic islands, and that more members of this tribe should be searched for in atypical habitats throughout the Pacific.

***Asteliamiris johnpolhemi*, new species**

Figures 1-17, 19

Diagnosis. The characters given in the generic diagnosis, especially the long legs and antenna, will distinguish this species from *Trigonotylus hawaiiensis* Kirkaldy

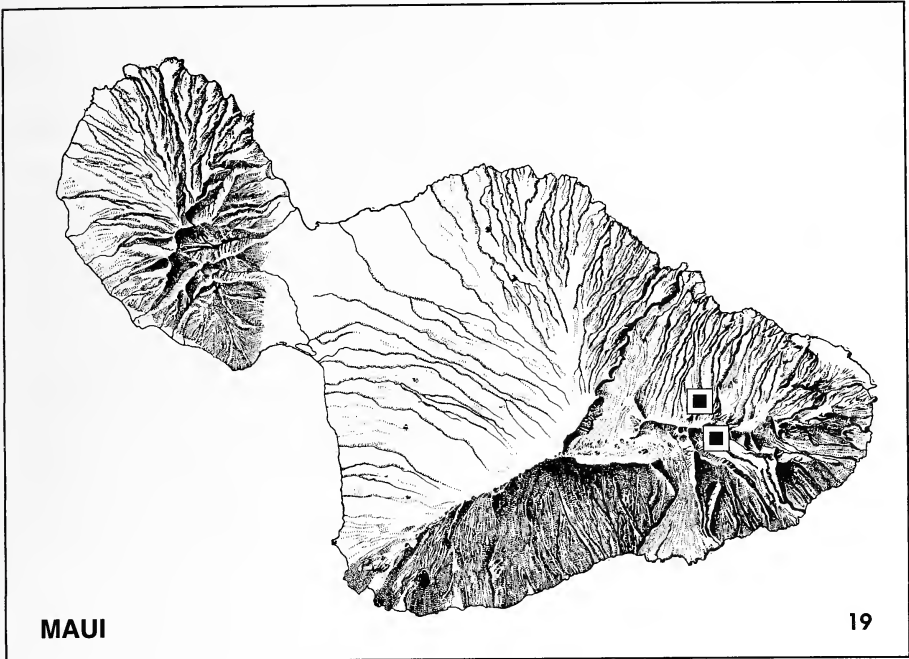


Fig. 19. Distribution of *Asteliamiris johnpolhemi* on Maui.

and *T. usingeri* Carvalho, which also occur on the Hawaiian Islands, but in the open, subalpine grassland zone above the upper montane wet forests where *A. johnpolhemi* is found.

Description. *Adult male.* Yellowish-green, with black subapical annulate ring on antennal segment 2, base and distal portion of segment 3, except apex, segment 4, and apex of tarsal segment 3. *Measurements* (N = 4; mean, range): Body length from apex of clypeus to apex of genital segment 4.50 (4.40–4.70); body length from apex of clypeus to apex of hemelytra 2.80 (2.65–3.00); length of hemelytra 1.43 (1.30–1.55); maximum width of pronotum 0.78 (0.73–0.80); median length of pronotum 0.57 (0.55–0.60); median length of head 0.83 (0.78–0.88); width of head across eyes 0.73 (0.69–0.76); vertex width 0.42 (0.40–0.43); dorsal eye width 0.17 (0.16–0.18) lateral height of eye 0.29 (0.28–0.29); labium length 1.84 (1.75–1.92); antennal measurements 1, 1.61 (1.54–1.68); 2, 3.17 (3.03–3.35); 3, 2.75 (2.55–3.05); 4, 1.48 (1.30–1.60). *Genitalia:* see Figs. 10–15.

Female. Similar to male except antennal segment 3 with more obvious wide basal and subapical black annuli. *Measurements* (N = 6; mean, range): Body length from apex of clypeus to apex of genital segment 5.26 (5.15–5.35); body length from apex of clypeus to apex of hemelytra 3.04 (2.85–3.25); length of hemelytra 1.59 (1.45–1.75); maximum width of pronotum 0.83 (0.78–0.88); median length of pronotum 0.60 (0.51–0.65); median length of head 0.85 (0.78–0.98); width of head across eyes 0.76 (0.74–0.79); vertex width 0.43 (0.40–0.45); dorsal eye width 0.16 (0.16–0.18)

lateral height of eye 0.28 (0.26–0.30); labium length 1.93 (1.85–2.00); antennal measurements 1, 1.61 (1.58–1.73); 2, 3.09 (2.85–3.28); 3, 2.57 (2.35–2.85); 4, 1.58 (1.55–1.65). *Genitalia*: see Figs. 16, 17.

Etymology. Named in honor of Dr. John T. Polhemus for his significant contributions to the study of Heteroptera.

Discussion. *Asteliimiris johnpolhemi* occurs in upper elevation wet forests on the windward slopes of Haleakala Volcano, eastern Maui. The type locality is a narrow, elongate ridge at the head of Kipahulu Valley, separating the drainages of Palikea and Koukouai streams, and known informally to workers at the Haleakala National Park as “Mauka Ridge” (the Hawaiian word “mauka” meaning to go upward in the direction of the mountains). The crest of this ridge is exposed to the prevailing trade winds, receiving large amounts of rain and mist, and supporting a closed canopy forest of ohia trees (*Metrosideros polymorpha* Gaudichard-Beaupré), with a relatively open understory below, containing scattered clumps of *Astelia menziesiana* Smith (Fig. 3). *Asteliimiris johnpolhemi* was moderately abundant within these *Astelia* clumps, from which individuals could be dislodged by beating or shaking the leaves over a net or beating sheet. When disturbed, the insects would often retreat to the undersides of leaves or deeper into the basal section of the plant, in a manner similar to those temperate zone mirids living on rosette plants such as *Yucca* or *Agave*.

Host. Breeds on *Astelia menziesiana* Smith (Liliaceae).

Distribution. Known from wet forests on the northern and eastern slopes of Haleakala, East Maui, Hawaiian Islands.

Types. Holotype, male, HAWAIIAN ISLANDS, **Maui**, Mauka Ridge, Kipahulu Valley, Haleakala National Park, 2,060 m (6,750 ft), 21 May 1998, 20°43.65'N, 156°07.43'W, ex *Astelia menziesiana* Smith (Liliaceae), CL 8334, D.A. Polhemus, deposited in National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Paratypes: HAWAIIAN ISLANDS, **Maui**: 9 males, 16 females, same data as holotype; deposited in the Bishop Museum, Honolulu, Hawaii; Canadian National Collection, Ottawa, Ontario, and USNM; 1 male, Haleakala, Poo Uli Cabin area, on north slope near headwaters of Kuhiwa Stream, Hanawi Natural Area Reserve, 1,585 m (5,200 ft), 5–6 May 1998, 20°45.03'N, 156°07.40'W, CL 8324, D. A. Polhemus (USNM).

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LITERATURE CITED

- Carvalho, J. C. M. 1952. Los insectos de las Islas Juan Fernandez 3. Miridae (Hemiptera), (Neotropical Miridae, LIV). *Revista Chilena de Entomologia* 2:21–24.
- Cobben, R. H. 1980. The Saldidae of the Hawaiian Archipelago (Hemiptera: Heteroptera). *Pacific Insects* 22(1–2):1–34.
- Polhemus, D. A. 1998. *Nysius aa* (Heteroptera: Lygaeidae), a new species of micropterous wekiu bug from the summit of Mauna Loa volcano, Hawaii. *Proceedings of the Entomological Society of Washington* 100(1):25–31.
- Polhemus, D. A. 1999. A new species of riparian Nabidae (Heteroptera) from the Hawaiian Islands. *Proceedings of the Entomological Society of Washington* 101(4):868–874.
- Schuh, R. T. 1995. Plant bugs of the world (Insecta: Heteroptera: Miridae). Systematic catalog, distributions, host list, and bibliography. The New York Entomological Society, xii+1329 pp.
- Schwartz, M. D. 1987. A phylogenetic review of the Mirinae and revision of the Stenodemini (Heteroptera: Miridae). Ph.D. thesis, City University of New York, New York.

REVISION OF THE SOUTH AMERICAN GENUS *HELLICA* STÅL
(HETEROPTERA: ACANTHOSOMATIDAE)

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The two new species described in this paper are dedicated to Dr. John T. Polhemus in recognition of his numerous contributions to entomology, especially for the aquatic and semiaquatic Heteroptera, and as a salute for the decades of our friendship.

Two emendations are proposed: Spelling of *Blaudinae* for Kumar's (1974:4, 18) subfamily "Bladusinae" and *Blaudini* for his (1974:18, 19) tribe "Bladusini," both having been based on the genus *Blaudus* Stål (1872:61).

Measurements are given in millimeters.

Genus *Hellica* Stål

Fig. 1

Hellica Stål, 1867:533.

Type-species: *Hellica nitida* Haglund, by subsequent monotypy.

Diagnosis. Among those genera of the tribe Lanopini Kumar (subfamily *Blaudinae*, emended spelling) with juga not surpassing the tylus and humeri not projecting beyond the outline of the costa, *Hellica* is recognizable by the very short peritreme that is virtually no longer than wide.

Discussion. Kumar (1974:28-29) based his redescription of this genus on Haglund's two males of *Hellica nitida*, which he designated lectotype and paralectotype, and remarked that females were unknown. For the present study, females were available for all three species at hand; all were found to have the Pendergrast organ present (Figs. 3, 5, 7) and restricted to the anterior half of abdominal segment VII (last pregenital segment). The male genital capsule is here shown in dorsal view with the parameres in their natural position (easily seen by gently lifting the apex of the hemelytral membrane).

Distribution. Argentina, Bolivia, and Brazil.

KEY TO SPECIES OF *HELLICA*

- 1. Abdomen ventrally dark brown to black with broad lateral margins abruptly yellow. Tylus weakly but noticeably surpassing apex of juga, weakly tumid, not depressed subapically 2
- Abdomen ventrally yellow to tan with punctures and a variable sublateral longitudinal stripe on each side fuscous to brown. Tylus reaching apex of juga, weakly but noticeably depressed subapically *johni* new species
- 2. Male: Genital capsule with apical margin weakly but distinctly broadly bilobed in middle third, its dorsal setae scattered as in Fig. 4. Female: 3rd genital plate laterally,

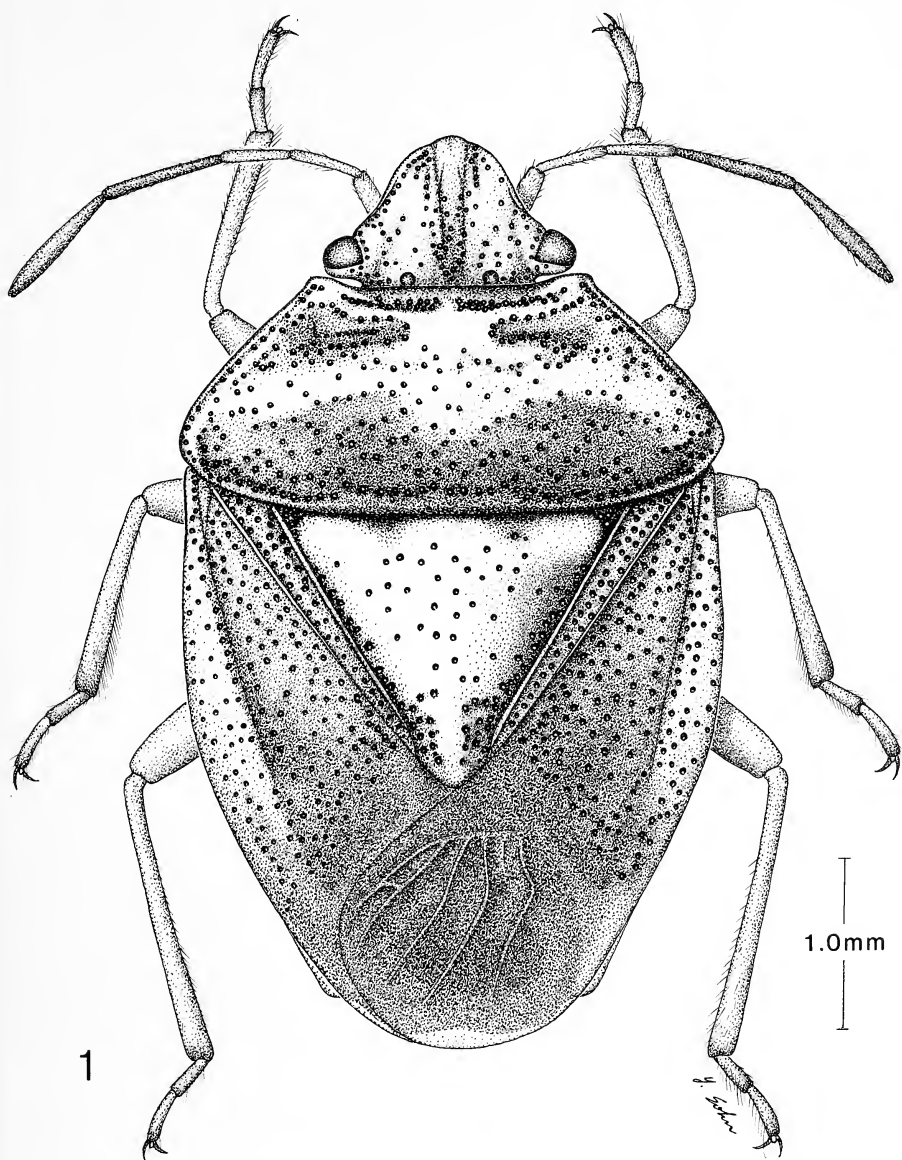


Fig. 1. *Hellica nitida* Hagland. Dorsal view.

- overlapping end of 2nd genital plate and in contact with basal genital plate as in Fig. 5 *johnpolhemi* new species
- Male: Genital capsule with apical margin not bilobed in middle third, its dorsal setae grouped as in Fig. 6. Female: 3rd and 2nd genital plates exposed to lateral ends as in figure 7 *nitida* Haglund

***Hellica johni*, new species**

Figs. 2, 3

Diagnosis. Abdominal venter yellow, with a tapering, longitudinal fuscous area of varying width on each side; the other two members of the genus have the abdomen black except for the abruptly delimited yellow lateral margins.

Description. (based on holotype male). Oval; length 5.2; width 2.9. General color yellow to brownish yellow, with calloused yellow areas and numerous mostly irregularly distributed brown punctures. Hemelytral membrane hyaline with some veins brownish. Venter yellowish, except for large brown areas each side of pale midline on visible segments II–IV, with numerous brown punctures except on calloused areas. Legs unicolorous brownish yellow; middle and posterior femora with a vague, brownish blotch near apical fourth of anterior face.

Head across eyes slightly wider than long, 1.2:1.0; preocular margin weakly elevated, abruptly concave a very short distance anterior to eye. Tylus flat, slightly depressed subapically, very slightly surpassing apex of juga, sides subparallel on apical half. Juga vaguely impressed apically. Antennal segments I–V in the ratio 0.26:0.43:0.30:0.46:0.54; first segment short, not reaching apex of head. Bucculae distinct, as long as labial segment I, abruptly terminated at narrowly conjoined posterior ends. Labium reaching anterior margins of middle coxae, apical segment black; segments I–IV in the ratio 0.43:0.55:0.27:0.27.

Pronotum more than twice as wide as midlength, 2.91:1.18; anterior margin deeply concave; lateral margins, except anterior fourth, nearly straight, humeri obtusely rounded, not prominent; disc with narrow, irregular, transverse calloused areas anterior and posterior to calli, some broadly joined between calli. Anterior half of posterior pronotal lobe with a broad, transverse calloused area; spaces between callouses with numerous brown punctures.

Scutellum shorter than basal width 1.36:1.67, yellow, with a vague, triangular brown spot basally on each side of midline and vaguely brownish each side near apex; surface with numerous irregularly scattered brown punctures, those along lateral margin forming a close-set row; apex narrowly rounded.

Hemelytron with costal outline gently convex. Corium nearly wholly yellow, subhyaline, with numerous slightly brownish punctures, latter slightly more dense on exocorium; apical margin of corium virtually straight. Membrane slightly surpassing apex of abdomen, hyaline, veins faintly darker; with a faint, brown, narrow line from midpoint of corium to apex of membrane.

Prosternum convex, neither grooved nor elevated. Ventral midline of thorax without elevated carinae. Metapleuron with ostiolar pore virtually on a line connecting basal limits of the middle and posterior acetabulae; peritreme very short, about as long as wide. Evaporative area restricted to a narrow halo around the peritreme, not approaching posterior flange of metapleuron.

Genital capsule and parameres in dorsal view as in Fig. 2, setae along posterior margin grouped in loose patches.

Legs concolorous brownish yellow, each femur with a vague, brownish blotch near apical fourth of anterior face.

Female. Similar to the male. Last pregenital segment (Fig. 3) with posterior margin

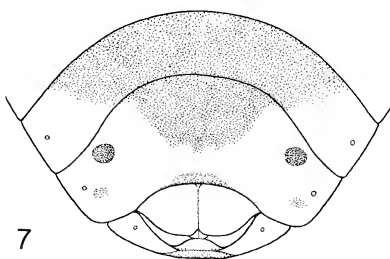
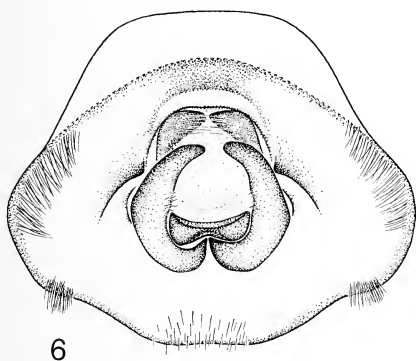
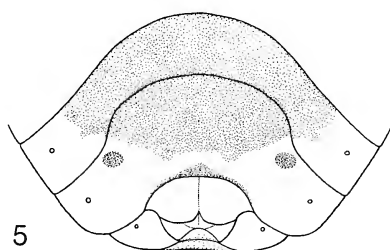
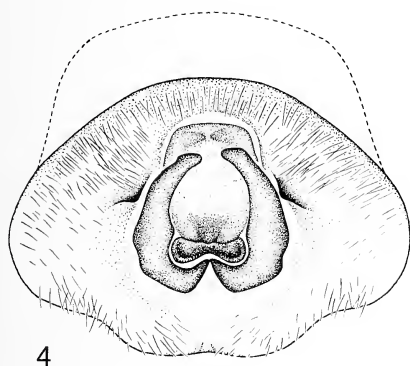
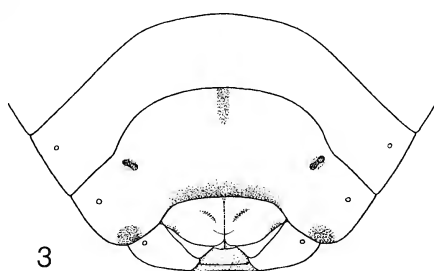
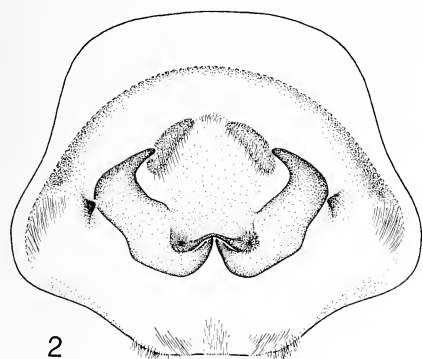


Fig. 2. *Hellica johni* n. sp. Dorsal view of male genital capsule.

Fig. 3. *Hellica johni* n. sp. Ventral view of apex of female abdomen.

Fig. 4. *Hellica johnpolhemi* n. sp. Dorsal view of male genital capsule.

Fig. 5. *Hellica johnpolhemi* n. sp. Ventral view of apex of female abdomen.

Fig. 6. *Hellica nitida* Haglund. Dorsal view of male genital capsule.

Fig. 7. *Hellica nitida* Haglund. Ventral view of apex of female abdomen.

broadly concave, virtually transverse in middle third. Lateral end of second plate not covered by third genital plate.

Types. Holotype male. ARGENTINA, Provincia de Buenos Aires, Juan B. Daguerre, 1968; collection J. Daguerre (National Museum of Natural History). Paratypes: ARGENTINA: 1 female, Formosa, Clorinda, XI.950, Daguerre; 1 male, 4 females [carded on 1 pin]; Bs. As, San Fernando, II.954, Daguerre; 1 male, 4 females (carded on one pin) same data as holotype. URUGUAY, 1 male, 1 female, Montevideo, Uruguay, Parker, 837-38, 45-14929 (all in National Museum of Natural History).

Discussion. Lengths of males vary from 5.0-5.3; of females from 4.7-5.6. The labium of one of the paratypes is slightly longer than that of the holotype and actually extends between middle coxae. The preapical flattening of the last pregenital segment of the paratype is a little stronger than that on the holotype.

Etymology. This new species name is derived from the given name of Dr. John T. Polhemus.

Hellica johnpolhemi, new species

Figs. 4, 5

Diagnosis. From the other two species in *Hellica* this one can be readily recognized by the mostly black abdomen (except lateral margins) and presence of two (usually joined) black blotches at base of scutellum or by conveniently available characters in each sex: in the male the apical margin of the genital capsule is broadly and shallowly bilobed in the middle third (Fig. 4); in the female the posterolateral margin of the third genital plate is convexly rounded, covering the lateral end of the second genital plate and slightly overlapping the posterior lateral angle of the basal genital plate (Fig. 5).

Description. Holotype male: Oval; length 6.2, width 3.5. General color dorsally yellow to tan with fuscous punctures; head basad of ocelli narrowly black; each pronotal callous with a transverse, anteriorly concave black line; base of scutellum with a conspicuous black blotch on each side of middle, these usually narrowly joined across midline, outer margin narrowly black almost to apex; clavus and mesocorium translucent, darker than opaque yellow exocorium; hemelytral membrane brownish. Ventrally black except for yellow on head, first 3 segments of labium, acetabula, legs, margins of abdomen, and genital capsule.

Head across eyes wider than long: 1.6:1.1; preocular margin weakly elevated along preocular concavity. Tylus weakly tumid, side diverging from near base, apex broader than and faintly surpassing apices of juga. Antennal segments I-V in ratio 0.32:0.50:0.40:0.72:0.81; segment I not reaching apex of head. Bucculae slightly surpassing apex of labial segment I, abruptly terminated posteriorly. Labium reaching between middle coxae; segments I-IV in ratio 0.60:0.67:0.38:0.31.

Pronotum slightly more than twice as wide as midlength, 3.5:1.5 anterior margin strongly concave; lateral margin nearly straight, apical and humeral angles rounded; disc with narrow transverse calloused area enclosing calli; posterior lobe slightly darker than anterior lobe, with numerous well-separated darkened punctures.

Scutellum as wide as long, 2.0:2.0; disc with scattered fuscous punctures; punctures along lateral margin forming a close-set row; apex narrowly rounded.

Hemelytron slightly surpassing apex of abdomen, costal margin weakly convex.

Abdomen polished, impunctate on middle third and lateral margins. Genital capsule, with parameres, as in figure 4, setae along apical margin scattered, not arranged in discrete patches.

Distribution. Known from Argentina, Brazil, and Bolivia.

Types. Holotype, male, BOLIVIA, Quime, 10,000 ft. Mulford Biological Exploration, 1921–22, Wm. Mann (National Museum of Natural History). Paratypes: same data as for holotype; 2 males, 1 female, ARGENTINA: Terri. [tory] Formosa, Gran Guardia, II-2-1953, Juan Foerster, J. C. Lutz collection 1961, 1 female; BRAZIL, Tafe del Valle, Quebradada la Angostura, 26-II-53, 1800 m., J. Herrera (U.S. National Museum of Natural History).

Discussion. The above general descriptive characters apply to both sexes. The paratypes are slightly larger than the holotype: males, 6.1–6.2, females, 6.3–6.5.

Because there were no males and females bearing the same locality data, there is a possibility they are improperly associated here, but the presence of the large, black, basal blotches on the scutellum of both sexes (absent on all available specimens of the other two species) was used as a convenient character for associating them.

This species name is formed from the two names of Dr. John T. Polhemus.

Hellica nitida Haglund

Figs. 1, 6, 7

Hellica nitida Haglund, 1868:161 [Brazil]. Lectotype chosen by Kumar, 1974:281. *Banasa pulchella* Berg, 1884:101 [Uruguay]. Synonymized by Thomas and Yonke, 1990:657.

Discussion. The narrow yellow margins of the extensive black area of the abdomen plus the wholly yellow scutellum will permit ready recognition of this species.

In addition to examining the two male types of *H. nitida*, numerous other specimens of both sexes from southern Brazil and the northern half of Argentina (Province of Buenos Aires and the Territories of Formosa and Misiones) were available for study.

Study of three of the six specimens from the type series of *Banasa pulchella* (Museo de La Plata, La Plata, Argentina) confirmed Thomas and Yonke's (1990: above) synonymizing this name with *Hellica nitida*; those specimens included two males glued to one rectangular card and one female glued to another card. The male double mount bore four labels: (1) (a) "B.O. San Juan"; (b) "Speg. II 84"; (2) "typus"; (3) an identification label in Berg's handwriting, "*Banasa pulchella* Berg"; and (4) a circle of blue paper marked "/1-2" and "1408." The left male is here designated lectotype and "lecto" was written on the card behind it. The other male is designated a paralectotype, as is the female on the other mount. The pin for the female mount (remounted on a cardboard point to permit viewing ventral structures) bore three labels, the same as 1, 2, and 4 above; to these was added a paralectotype label.

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LITERATURE CITED

- Berg, C. 1884. Addenda et Emendanda ad Hemiptera Argentina. An. Soc. Cient. Argent. 17(1): 105-125.
- Haglund, J. C. E. 1868. Hemiptera nova. Stett. Entomol. Zeitg. 29:150-163.
- Kumar, R. 1974. A revision of the world Acanthosomatidae (Heteroptera: Pentatomidae): keys to and descriptions of subfamilies, tribes and genera, with designation of types. Aust. Sci., Suppl. Ser. No. 34:1-69 [A corrected title page was issued and changed the word "Pentatomidae" to "Pentatomoidea"].
- Stål, C. 1867. Bidrag till Hemipterernas Systematik. Öfv. Kongl. Sven. Vet.-Akad. Forh. 24: 491-560.
- Stål, C. 1872. Enumeratio Hemipterorum. 2. Kongl. Svens. Vet.-Akad. Handl. 10:1-159.
- Thomas, D. B. and T. R. Yonke. 1990. A review of the genus *Banasa* (Hemiptera: Pentatomidae) in South America. Ann. Entomol. Soc. Am. 83:657-688.

**NAUCORIDAE (HETEROPTERA) OF NEW GUINEA. 5.
A REVIEW OF *TANYCRICOS* LA RIVERS IN IRIAN JAYA,
WITH DESCRIPTIONS OF TWO NEW SPECIES**

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Abstract.—Two new species of *Tanycricos* are described and illustrated from the Indonesian province of Irian Jaya, comprising western New Guinea: *T. jaetipi* n. sp. and *T. ziwa* n. sp., both from the upper Wapoga River basin. Additional records are given for previously described species of *Tanycricos* in Irian Jaya, and island wide distribution maps are provided for all species in the genus.

The genus *Tanycricos* was proposed by La Rivers (1971) to hold a set of impressively large naucorids from the central mountains of New Guinea. An additional species was described by Polhemus and Polhemus (1986), who also provided a revised key.

Due to disproportionate collecting effort in eastern New Guinea, all but one of the previously named species in the genus were described from that half of the island, comprising the country of Papua New Guinea. The exception, *T. acumentum* La Rivers, was described from the Star Mountains of Irian Jaya, but also occurs widely in the central ranges of Papua New Guinea as well. Until now, no species of *Tanycricos* was known to be strictly endemic to western New Guinea, the Indonesian province of Irian Jaya, thereby producing the impression that the genus was disproportionately speciose in the east. This picture has changed, however, based on recent collections from the Wapoga River basin of northwestern Irian Jaya, which have led to the discovery to two new species, described below. These new taxa are apparently restricted to the western portion of the island's central ranges, and indicate that speciation in the genus is more geographically balanced than was previously evident.

All measurements are in millimeters. Specimen depository abbreviations are as indicated in the acknowledgments. The notation "PTFI" in the material examined sections refers to the P. T. Freeport Indonesia mining company, which provided logistical support for the Wapoga Basin surveys. CL numbers refer to collection numbering codes used by the author to cross reference specimens, photographs, and ecological data.

***Tanycricos jaetipi*, new species**

Figs. 1-3, 6, 8

Diagnosis. A large, robust *Tanycricos* species (Fig. 1), recognized by the shapes of the male parameres (Figs. 2, 3) and the female subgenital plate (Fig. 6).

Description. *Brachypterous male.* Large for genus, form robust (Fig. 1), basic coloration medium yellowish brown, shaded with darker brown on hemelytra, at muscle

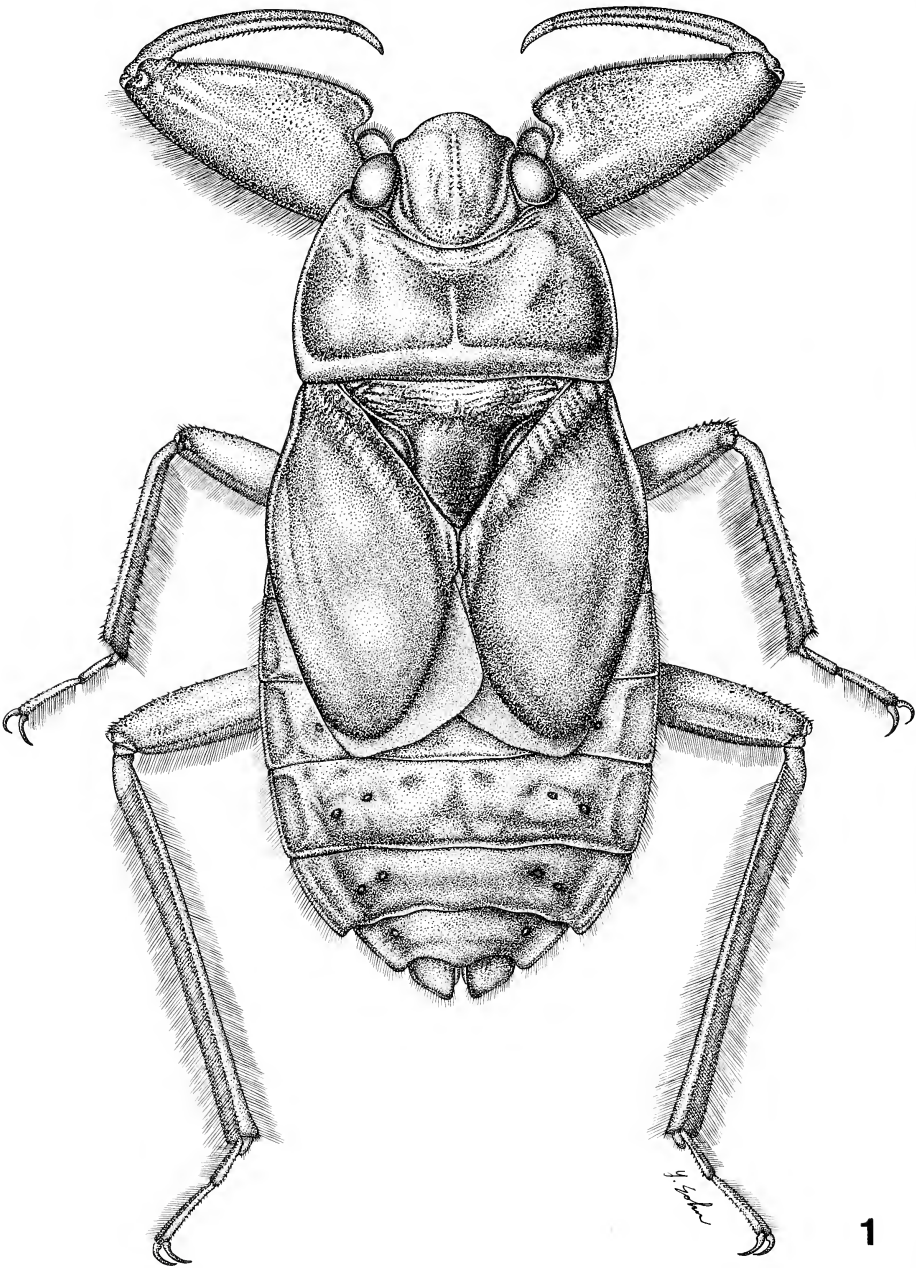
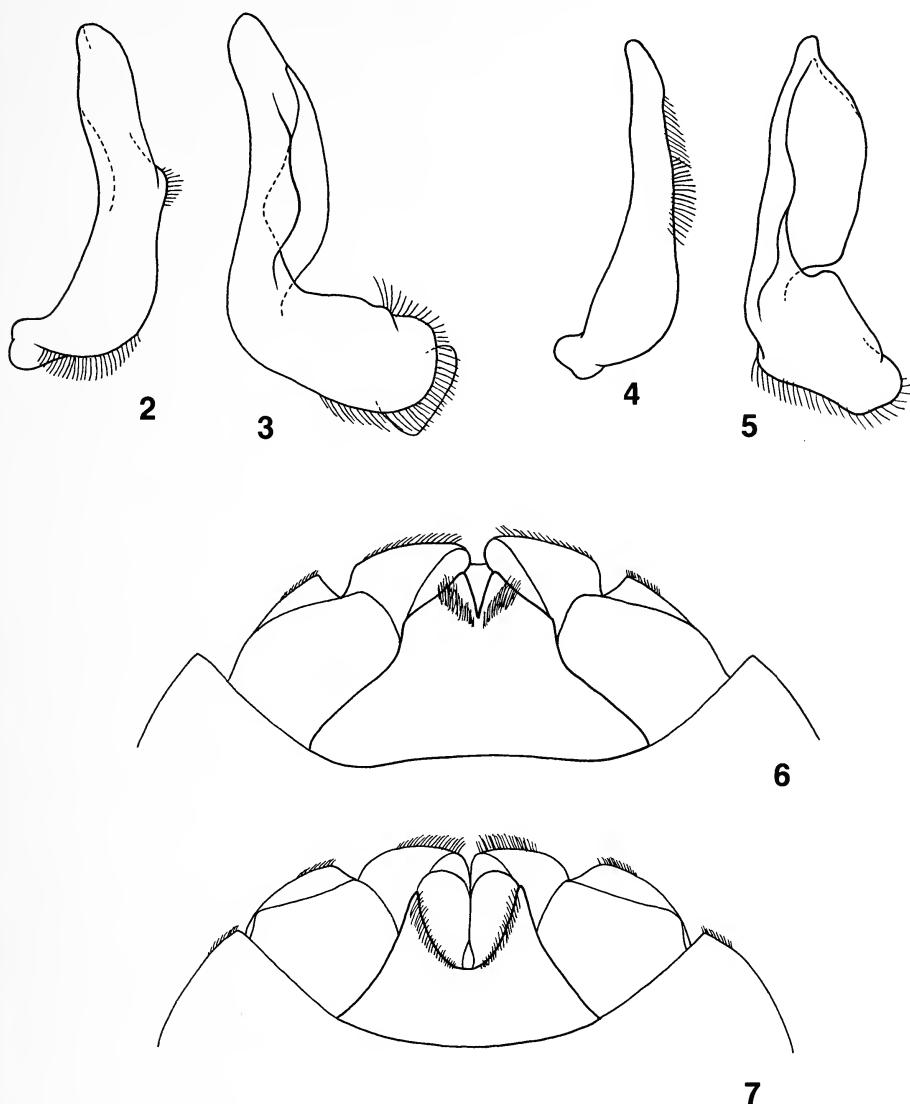


Fig. 1. *Tanycricos jaetipi*, brachypterous female, dorsal habitus.



Figs. 2–7. Male parameres of *Tanycricos* species. 2. *T. jaetipi*, left paramere. 3. *T. jaetipi*, right paramere. 4. *T. ziwa*, left paramere. 5. *T. ziwa*, right paramere. 6. Female subgenital plates of *Tanycricos* species. 6. *T. jaetipi*. 7. *T. ziwa*.

attachment scars on pronotum, and on dorsal abdomen. Length 19.90; maximum width (across abdomen) 8.60.

Head yellowish brown, slightly darker along longitudinal midline and adjacent to eyes, width/length 4.45/3.30; eyes black, shining, rounded, protrusive, anterior/posterior interocular width 2.70/2.90, eyes separated from vertex by deep furrows; an-

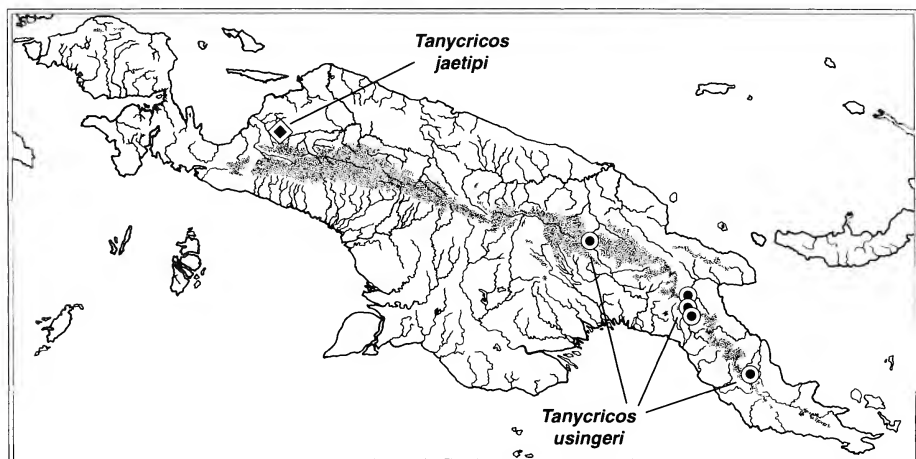


Fig. 8. Distribution of *Tanycricos jaetipi* n. sp. and *Tanycricos usingeri* La Rivers in New Guinea.

teclypeus with basolateral sections adjoining anterior apices of eyes thinned and slightly explanate, apex with a pair (1+1) of shallow depressions to either side of midline, greatly produced anteriorly, projecting far beyond base of labrum and apices of maxillary plates; labrum dark yellow, anterior margin broadly rounded; maxillary plates well developed, horizontally oriented basally, anterior margins upturned vertically along margins of rostral cavity; antennae slender, yellowish, segment IV longest, with tip barely exceeding lateral eye margin; vertex well produced posteriorly behind eyes, margin evenly rounded.

Pronotum dull yellowish brown, mottled with darker brown, weakly depressed medially behind vertex of head, width/length (midline) 7.10/3.15, lateral margins broadly arcuate, posterior margin weakly bisinuate, delineated by a deep furrow, anterolateral angles acute, rounded, posterolateral angles obtuse, rounded. *Scutellum* medium brown, width/length (midline) 5.25/3.30, lateral margins weakly sinuate, basal section with deep transverse sulcus, central section shining. *Wings* dark brown, with fine granular microstructure, brachypterous, truncate posteriorly, apices extending to basal section of abdominal tergite IV, embolium delineated by a sinuate furrow, margin narrowly gold, clavus obscure, membrane represented by a narrow dark flap posteriorly, posterior margin gently curved, venation of hemelytron and membrane absent.

Abdomen medium brown, with lateral sections of tergites I and II, lateral and posterior sections of tergite III, all of tergite IV, lateral sections of tergite V, lateral and posterior sections of tergite VI, and lateral sections of tergite VII exposed; lateral margins of all segments fringed with a few long, fine, recumbent, gold setae; posterolateral angles of all segments rounded or gently angulate, not produced or spinose; visible lateral sections of tergite V not asymmetrical; visible lateral sections of tergite VI each bearing an elongate, raised patch of short dark setae along entire anterior margin.

Ventral surface medium brown, head, medial portions of thoracic plates, and abdominal sternites with dense covering of shining, recumbent gold setae; head with prominent medial keel bearing a small raised tooth at posterior apex; prosternum with low longitudinal medial carina, more prominently raised anteriorly; proepimeron bearing an elongate oval golden sense organ set inside lateral margin behind anterolateral angle, mesosternal plate small, not raised, lacking a medial carina; mesepimeron, metasternum, and metepimeron bare, lacking hydrofuge pile; abdominal paratergites I–VI with scattered paired, glabrous, ovate depressions in the hair pile lying inward from spiracles; spiracles marked by slightly raised hair clumps.

Legs dark yellowish brown to medium brown, finely spotted with dark brown on dorsal surface of fore femur; anterior femora with posterior margin bearing a ridge of small dark tubercles lying just posterior to a band of long, recumbent gold setae, anterior margin bearing a thick pad of short, stiff gold setae; anterior tibia slender, gently curving, bearing a single tarsal segment and claw; middle and posterior coxae each with single raised brown tubercle apically; middle and posterior femora bearing numerous tiny reddish spinules on anterior and posterior faces; middle and posterior tibiae set with numerous small, reddish spines and spinules, apices with 5 and 6 transverse rows of reddish spines respectively; middle and posterior femora, tibiae and tarsi all bearing fringes of long, golden swimming hairs along posterior margins; claws sharply bent, tips dark, parempodia setiform.

Genitalia with left paramere moderately stout, broadly curving, bearing a small projecting tab near the center of the outer margin (Fig. 2); right paramere L-shaped, distal section fluted, with an elongate depression on the inner face that cradles the phallosome when the structures are at rest (Fig. 3).

Brachypterous female. Similar to brachypterous male in general structure and coloration, but with following exceptions: length 17.60, maximum width (across abdomen) 8.35. *Subgenital plate* narrowed on distal section, with a deep, V-shaped medial incision at tip (Fig. 6).

Macropterous female. Similar to brachypterous male in general structure and coloration, but with following exceptions: Form slender and parallel sided, length 19.00, maximum width (across abdomen) 8.05; scutellum shining black, raised, swollen; hemelytra with clavus and claval vein well defined, membrane in existing specimen disintegrated; prosternum raised and swollen posteromedially.

Macropterous male. Unknown.

Etymology. The name “*jaetipi*” is an arbitrary combination of letters that is acoustically identical to the initials of John T. Polhemus, and thereby honors this outstanding heteropterist.

Discussion. In general appearance, *T. jaetipi* is similar to *T. usingeri*, but the two species may be immediately separated by the shape of the male parameres (Figs. 2, 3), and the shape of the female subgenital plate (Fig. 6). The lateral tab on the outer margin of the left paramere that is diagnostic for *T. jaetipi* shows only an incipient development in *T. usingeri* (see Polhemus and Polhemus, 1986, Fig. 4), and the distal portion of the paramere is more slender in this species. In females of *T. jaetipi* the medial incision at the posterior apex of the subgenital plate is relatively narrow, shallow, and V-shaped (Fig. 6), while in *T. usingeri* it is much deeper and widens to form a rounded opening near the center of the plate (see Polhemus and Polhemus,

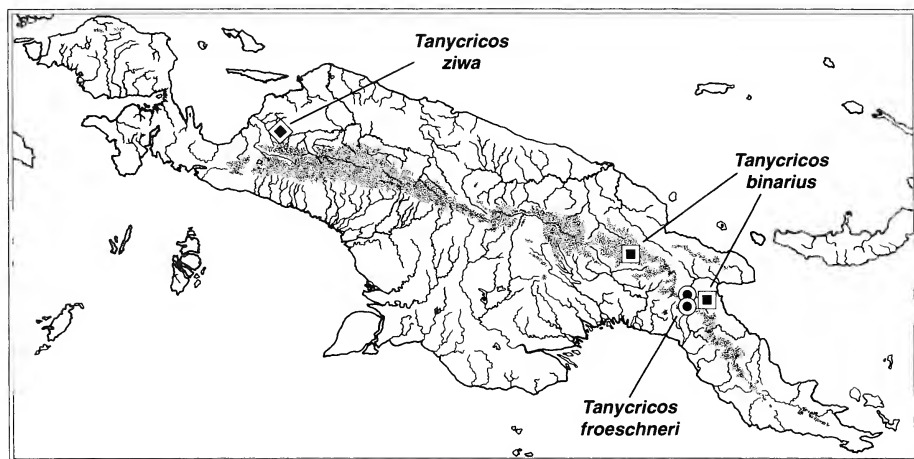


Fig. 9. Distribution of *Tanycricos ziwa* n. sp., *Tanycricos binarius* La Rivers, and *Tanycricos froeschneri* Polhemus & Polhemus in New Guinea.

1986, Fig. 19). The two species occupy ranges at opposite ends of the New Guinea central ranges (Fig. 8), and may eventually prove to be sister taxa.

The type series was taken along the margins of the Ziwa River, a large, very swift river dropping rapidly through a mostly unshaded bed of igneous boulders, rocks and cobbles. The few specimens obtained were taken from scattered shallow pockets along the stream margins where current speed was moderated, allowing localized deposition of smaller cobbles and gravel; one such area included the mouth of the small tributary from which the type series of *Tanycricos ziwa* was obtained (see below). These same areas also supported additional naucorids in the genera *Idiocarus* and *Nesocricos*.

Types. Holotype: brachypterous female, INDONESIA, **Irian Jaya Prov.**, New Guinea, upper Ziwa River at PTFI Wapoga Alpha drilling camp, 1,050 m (3,500 ft), water temp. 19°C, 19 April 1998, 08:00–12:00 h, 3°08.69'S, 136°34.42'E, CL 7101, D. A. Polhemus (LIPI). Paratypes: INDONESIA, **Irian Jaya Prov.**, New Guinea: 1 brachypterous male, 1 macropterous female, same data as holotype (USNM).

***Tanycricos ziwa*, new species**

Figs. 3, 4, 7, 9

Diagnosis. A relatively small and slender *Tanycricos* species, recognized by the shapes of the male parameres (Figs. 4, 5) and the female subgenital plate (Fig. 7).

Description. *Brachypterous male.* Small for genus, form elongate, basic coloration yellowish brown, shaded with darker brown on hemelytra and at muscle attachment scars on pronotum. Length 14.50; maximum width (across abdomen) 7.15.

Head yellowish brown, slightly darker along longitudinal midline and adjacent to eyes, width/length 3.75/2.95; eyes dark brown, shining, rounded, protrusive, anterior/posterior interocular width 2.15/2.20, eyes separated from vertex by deep furrows; anteclypeus with basolateral sections adjoining anterior apices of eyes thinned and

slightly explanate, apex with a pair (1+1) of shallow depressions to either side of midline, greatly produced anteriorly, projecting far beyond base of labrum and apices of maxillary plates; labrum dark yellow, anterior margin broadly rounded; maxillary plates well developed, horizontally oriented basally, anterior margins upturned vertically along margins of rostral cavity; antennae slender, yellowish, segment IV longest, with tip barely exceeding lateral eye margin; vertex well produced posteriorly behind eyes, margin evenly rounded.

Pronotum yellowish brown, mottled with darker brown, weakly depressed medially behind vertex of head, width/length (midline) 5.75/2.50, lateral margins broadly arcuate, posterior margin weakly bisinuate, delineated by a deep furrow, anterolateral angles acute, sharp, posterolateral angles obtuse, rounded. *Scutellum* yellowish brown, width/length (midline) 2.25/4.20, lateral margins weakly sinuate, basal section with deep transverse sulcus, central section rugulose, posterior apex with transverse striae. *Wings* dark brown, with fine granular microstructure, brachypterous, truncate posteriorly, not attaining posterior margin of abdominal tergite III, embolium golden yellow, delineated by a sinuate furrow, clavus obscure, membrane represented by a small dark flap posteriorly, venation of hemelytron and membrane absent.

Abdomen medium brown, with lateral sections of tergites I and II, lateral and posterior sections of tergite III, all of tergite IV, lateral sections of tergite V, lateral and posterior sections of tergite VI, and lateral sections of tergite VII exposed; lateral margins of all segments fringed with short, stiff gold setae and long, fine, recumbent, gold setae; posterolateral angles of all segments rounded or gently angulate, not produced or spinose; visible lateral sections of tergite V slightly asymmetrical, more greatly produced on left side; visible lateral sections of tergite VI each bearing a round, raised patch of short dark setae near anterior margin.

Ventral surface medium brown, head, medial portions of thoracic plates, and abdominal ventrites with dense covering of shining, recumbent gold setae; head with prominent medial keel lacking teeth at anterior and posterior apices, prosternum with low longitudinal medial carina, more prominently raised anteriorly; proepimeron bearing an elongate oval golden sense organ set inside lateral margin behind anterolateral angle, mesosternal plate small, not raised, lacking a medial carina; mesepimeron, metasternum, and metepimeron bare, lacking hydrofuge pile; abdominal paratergites I–VI with scattered paired, glabrous, ovate depressions in the hair pile lying inward from spiracles; spiracles marked by slightly raised hair clumps.

Legs dark yellowish, finely spotted with brown on dorsal surface of fore femur; anterior femora with posterior margin bearing a ridge of small dark spinules lying just posterior to a band of long, recumbent gold setae, anterior margin bearing a thick pad of short, stiff gold setae; anterior tibia slender, gently curving, bearing a single tarsal segment and claw; middle and posterior coxae each with single raised gold tubercle apically; middle and posterior femora bearing numerous small, dark spinules on anterior and posterior faces; middle and posterior tibiae set with numerous small, dark spines and spinules, apices with 4 and 5 transverse rows of dark spines respectively; middle and posterior femora, tibiae and tarsi all bearing fringes of long, golden swimming hairs along posterior margins; claws sharply bent, tips dark, parempodia setiform.

Genitalia with left paramere slender and tapering (Fig. 4); right paramere with

distal section greatly expanded, forming a broad depression which cradles the phalotheca when the structures are at rest (Fig. 5).

Brachypterous female. Similar to brachypterous male in general structure and coloration, but with following exceptions: form broader and more pear-shaped due to posterior widening of abdomen, length 14.40, maximum width (across abdomen) 7.30; abdominal asymmetry absent. *Subgenital plate* broadly and deeply incised medially, leaving a pair (1 + 1) of slender, tapering projections to either side of midline (Fig. 7).

Macropterous form. Unknown.

Etymology. The name "ziwa" is a noun in apposition and refers to the Ziwa River type locality.

Discussion. *Tanycricos ziwa* n. sp. runs to *T. usingeri* La Rivers in the key of Polhemus and Polhemus (1986) due to the unmodified posterolateral abdominal angles in both sexes, but can be easily separated from that species by its smaller size, less robust form, differently shaped male parameres (Figs. 4, 5), and differently shaped female subgenital plate (Fig. 7). The male left paramere is most similar in overall form to that of *T. acumentum* La Rivers (see Polhemus and Polhemus, 1986, Fig. 2), but is not as slender on the distal half. Similarly, the female subgenital plate has a broad central incision similar to that of *T. acumentum* (see Polhemus and Polhemus, 1986, Fig. 17), but in *T. ziwa* this incision is extremely deep and broad, dividing the distal section of the plate into a pair of acuminate processes (Fig. 7).

The type series was taken from a clear, shallow tributary to the upper Ziwa River, flowing in a bed of rocks, cobbles, and gravel, and shaded by primary montane rain forest. Most of the specimens were taken in an open cobble run, with moderate current speed and water varying from 0.25 to 0.50 m in depth. Adults appeared to prefer situations in the lee of larger rocks, while immatures were more widely distributed amid the cobbles and gravels, occurring sympatrically with several *Idiocarus* species.

Types. Holotype: female, INDONESIA, **Irian Jaya Prov.**, New Guinea, rocky rain-forest tributary to upper Ziwa River at PTFI Wapoga Alpha drilling camp, 1,050 m, (3,500 ft), water temp. 20°C, 18 April 1998, 10:00–17:00 h, 3°08.69'S, 136°34.42'E, CL 7100, D. A. Polhemus (LIPI). Paratypes: INDONESIA, **Irian Jaya Prov.**, New Guinea: 5 females, same data as holotype (USNM, JTPC); 1 male, upper Ziwa River at PTFI Wapoga Alpha drilling camp, 1,050 m (3,500 ft), water temp. 19°C, 19 April 1998, 08:00–12:00 h, 3°08.69'S, 136°34.42'E, CL 7100, D. A. Polhemus (USNM).

Tanycricos acumentum La Rivers

Fig. 10

Tanycricos acumentum La Rivers, 1971, 2: 5.

Discussion. This species has proven to be widespread throughout the entire central mountain chain of Irian Jaya at elevations above 1,000 meters.

Material examined. INDONESIA, **Irian Jaya Prov.**, New Guinea: 9 brachypterous males, 2 brachypterous females, swift rocky stream in upper Pass Valley, 52 km. NE of Wamena, 2,015 m (6,600 ft), water temp. 14°C, 23 September 1991, CL 2614, D. A. and J. T. Polhemus (JTPC, BPBM, LIPI); 13 brachypterous males, 6 brachypterous females, 34 immatures, Okilik River, 5 km. SE of Wamena, 1,850 m (6,070

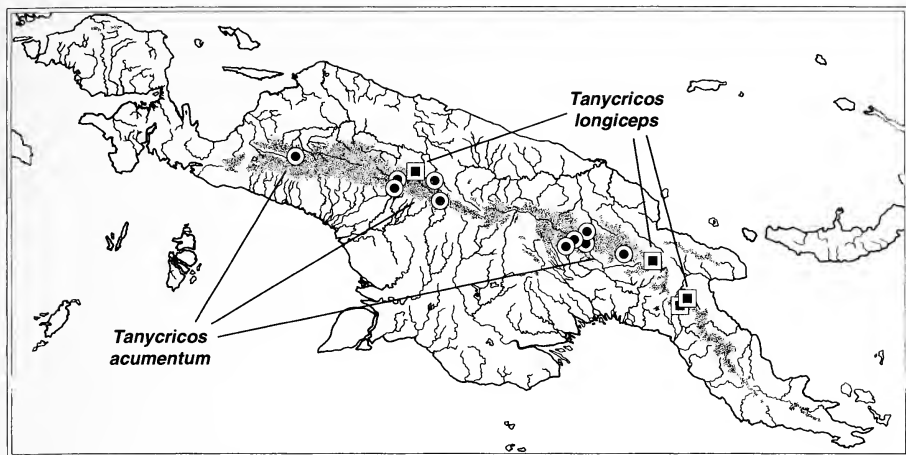


Fig. 10. Distribution of *Tanycricos longiceps* La Rivers and *Tanycricos acumentum* La Rivers in New Guinea.

ft), 5 January 1992, R. Ubaidillah (JTPC, BPBM, LIPI); 1 macropterous male, 2 macropterous females, 1 brachypterous male, Bime, 1,400 m, 4°30'S, 140°12'E, 11 September 1993, Balke and Reidel (NHMW, USNM); 1 macropterous male, 1 brachypterous male, 1 brachypterous female, Juarima, trib. to Baliem River, 1,850 m, 13 October 1993, Balke and Reidel (NHMW, USNM); 5 males, 2 females, Wabu River below PTFI Bilogai exploration camp, 2,105 m (6,900 ft), water temp. 17°C, 1 April 1997, 08:30–14:00 h, 3°44.69'S, 137°01.75E, PTFI aquatic biodiversity sampling station #39, CL 7083, D. A. & J. T. Polhemus (USNM, LIPI).

Tanycricos longiceps La Rivers

Fig. 10

Tanycricos longiceps La Rivers, 1971, 2: 10.

Discussion. This is the first record of this species for Irian Jaya, and comes from the Star Mountains, a mountain range that also extends eastward into Papua New Guinea.

Material examined. INDONESIA, **Irian Jaya Prov.**, New Guinea: 2 macropterous males, 1 macropterous female, Emdoman, 800–1,000 m, 4°12'S, 139°55'E, 28 September 1993, Balke and Reidel (NHMW, USNM).

ACKNOWLEDGMENTS

I wish to thank Burke Burnett and Andy Mack of Conservation International for organizing the survey of the Wapoga River basin under their Rapid Assessment Program, which led to the discovery of the two new species of *Tanycricos* reported herein. Special thanks are also due to Scott Baker and Peter C. van den Hoek Ostende ("Papa Tango") of the P. T. Freeport Indonesia (PTFI) exploration division, and to Howard Lewis and Kent Hortle of the PTFI environmental laboratory, who coordinated logistical support for the Wapoga Basin surveys.

The holotypes of the new species described herein are deposited in the collection of the

Indonesian Institute of Sciences, at Cibinong, Java (LIPI); paratypes are held in the National Museum of Natural History, Smithsonian Institution (USNM), and in the J. T. Polhemus collection, Englewood, Colorado (JTPC).

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LITERATURE CITED

- La Rivers, I. 1971. Studies of Naucoridae (Hemiptera). Biol. Soc. Nevada Mem., 2:1-120.
- Polhemus, D. A. and J. T. Polhemus. 1986. Naucoridae of New Guinea. III. A review of the genus *Tanycricos* La Rivers, with the description of a new species. J. New York Entomol. Soc., 94(2):163-173.

**REEVALUATION OF THE PLANT BUG GENUS *ICODEMA*,
WITH DESCRIPTIONS OF TWO NEW GENERA TO
ACCOMMODATE FIVE NEARCTIC SPECIES
(HETEROPTERA: MIRIDAE: PHYLINAE)**

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Abstract.—Study of *Icodema nigrolineatum* (Knight) has shown that it and four other related Nearctic species are not congeneric with Palearctic *I. infuscatum* (Fieber), the type of the genus. As a result, the new genus *Americodema* is established to accommodate *A. nigrolineatum* (Knight), new combination, and *A. knighti* (Kerzhner and Schuh), new combination, and the new genus *Occidentodema* is erected for the three new species *O. clypealis*, *O. mcfarlandi*, and *O. polhemusi* from the western United States and Mexico. Generic relationships are discussed, host plants and distributions are reviewed, and diagnostic information and a key to species are provided to facilitate recognition.

Key words: Heteroptera, Miridae, Phylinae, *Icodema*, *Americodema*, *Occidentodema*, new genera, new species, hosts, distribution.

Icodema was established to hold the European *Plagiognathus infuscatum* Fieber (Reuter 1875). The genus remained monotypic until Carvalho (1955) transferred the Nearctic *Plagiognathus nigrolineatus* Knight into it, thus giving *Icodema* Holarctic status. Little information is available on the relationship of *Icodema* to other phylinae genera, although I (Henry 1989) noted that members of *Icodema*, *Cariniocoris* Henry, and the Palearctic genus *Phylus* Hahn also possessed a distinct keel on the ventral surface of the male genital capsule and lacked spots at the bases of the tibial spines, suggesting that they might form a monophyletic group.

The present paper was prompted by the discovery of four other Nearctic species also possessing keels on the male genital capsule. Close examination of this material and specimens of the widespread *I. nigrolineatum* indicated that, although these species are quite similar, none is congeneric with the Old World *I. infuscatum*. Based on male genitalia, *I. nigrolineatum* and *Plagiognathus knighti* Kerzhner and Schuh form an eastern species pair, and three new species from the western United States and Mexico form another group, each of which is considered to represent a new genus described in this paper.

Herein, I redescribe *Icodema* and its only included species *I. infuscatum* and establish the new genus *Americodema* to accommodate *I. nigrolineatum* and *Plagiognathus knighti*, and the new genus *Occidentodema* for the three new species *O. clypealis*, *O. mcfarlandi*, and *O. polhemusi* from the western United States and Mexico. A habitus drawing of *A. nigrolineatum*, scanning electron micrographs of selected structures for the five Nearctic species, figures of male genitalia of all species,

and a key to the species of *Americodema* and *Occidentodema* are provided to aid their recognition. All taxa are presented alphabetically by genus and species.

The following abbreviations are used for institutions cited in this paper: AMNH (American Museum of Natural History, New York); JTPC (J. T. Polhemus Collection, Englewood); BNHM (The [British] Natural History Museum, London); CAS (California Academy of Sciences, San Francisco); TAM (Texas A & M University, College Station); UBC (University of California, Berkeley); and USNM ([United States] National Museum of Natural History, Smithsonian Institution, Washington, DC).

Americodema, new genus

Type species. *Plagiognathus nigrolineatus* Knight 1923.

Diagnosis. Species of this genus are recognized by a combination of the uniformly pale greenish-white to greenish coloration, with or without fuscous stripes and spots on the antennae and legs, the lack of spots at the bases of the tibial spines (except for indistinct spots on some metatibial spines), the keeled male genital capsule, the relatively stout, twisted, strongly S-shaped vesica, and by the slender phallosome lacking a lateral notch as is found in *Icodema*.

Description. Length 3.28 to 4.40 mm. Elongate, oval. General coloration pale green to greenish white, with or without fuscous lines and spots on the legs and antennae. Head much broader than long; eyes prominent, granulate, more so in males; vertex about $\frac{1}{2}$ the width of head in males, slightly greater than $\frac{1}{2}$ in females. Rostrum extending to metacoxae; length of segments I, II, and IV subequal, segment III slightly shorter. Antennae slender, moderately long, ranging from 0.65–0.70 the length of body in δ δ , 0.63–0.67 in η η ; segment I shortest, stoutest; segment II longest, segment III ranging from 0.54–0.64 the length of II in δ δ , from 0.48–0.62 in η η ; segment IV slightly longer than I. Pronotum trapeziform, about two times wider at base than median length; scutellum equilateral. Hemelytra subparallel, opaque to translucent, particularly on corium; pubescence short, simple, recumbent; membrane translucent with two distinct areoles. Legs slender, often marked with spots or narrow fuscous lines; tibial spines lacking dark spots at bases, metatibiae sometimes with a few indistinct dark spots at bases of basal spines; claws with hairlike parempodia. Male genital capsule with a distinct median keel ventrally (Figs. 3–6, 10–13), extending from base of segment to truncated caudal area just below aperture; left (Figs. 14, 18) and right (Figs. 15, 19) parameres typically phyline; vesica stout, strongly twisted, S-shaped (Figs. 16, 20), with a large, distinct, subapical secondary gonopore; phallosome (Figs. 17, 21) slender, narrowly tapered to apex, without lateral notch or tooth.

Etymology. The generic name *Americodema* is created by combining a prefix from the locality name "America," often used instead of United States of America, and from the root of the generic name *Icodema* to reflect the historical association of the species in this genus to the Palearctic *Icodema infuscatum*. The gender is interpreted as neuter, following Steyskal (1973).

Discussion. Males of *Americodema* and *Icodema*, as well as those of the new genus *Occidentodema*, possess a distinct keel that appears to be formed by the bilaterally compressed ventral edge of the genital capsule. As pointed out by Henry (1989), at

least two other genera also are known to have well-developed genital keels. The Nearctic *Cariniocoris* and the predominately Palearctic [*P. coryli* (L.) introduced into northwestern North America] genus *Phylus* have keel-like carinae on the male genital capsule, but these structures are reduced to simpler, more narrow ridges and probably are not homologous.

All keel-bearing genera mentioned above lack distinct dark spots at the bases of the tibial spines that are typical of most other phylines, but the absence of spots is widespread in the subfamily and likely reflects convergence. I note that one of the two species of *Americodema* (*A. nigrolineatum*) and all three species of *Occidentodema* do have some indistinct dark spots, primarily on the basal three or four spines of the hind tibia, a condition not found in the other three genera.

Species of *Americodema*, *Icodema*, *Occidentodema*, and *Phylus* have a generally S-shaped vesica, whereas *Cariniocoris* has a more C-shaped vesica. The vesica is slender in *Icodema* and distinctly more stout in *Occidentodema*, *Phylus*, and *Americodema*; however, the secondary gonopore in *Icodema* and *Phylus* is positioned well back from the apex near the middle of the vesica, whereas in *Americodema* and *Occidentodema* it is apical or subapical.

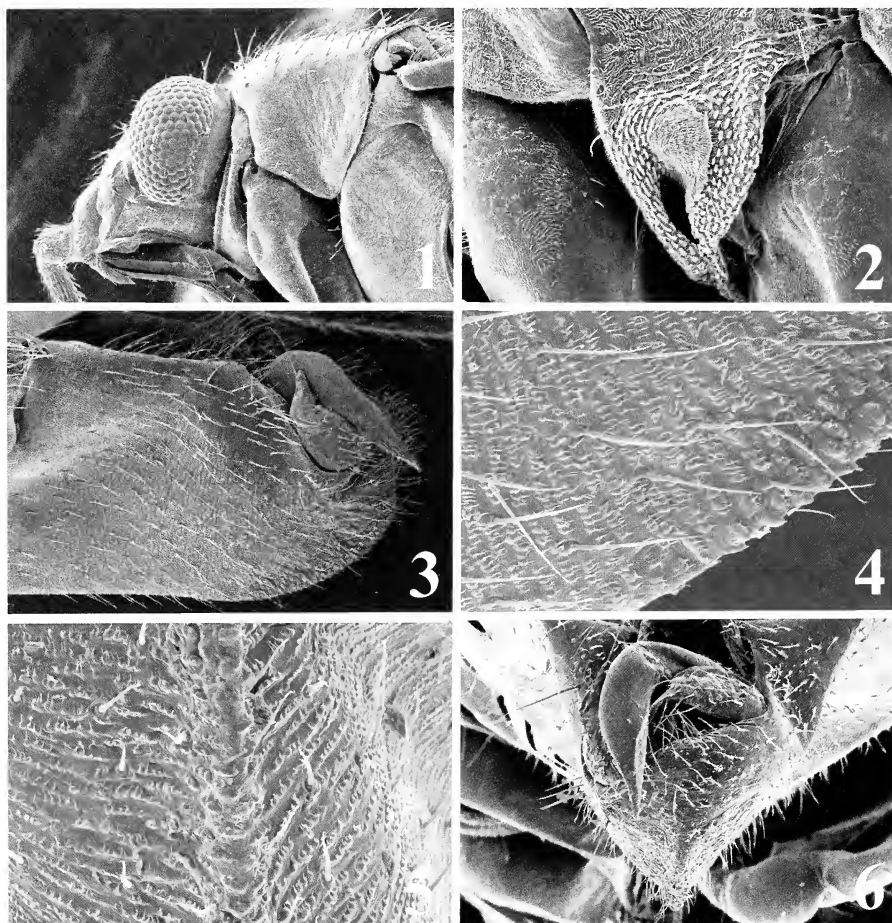
The vesica of the species I am including in *Americodema* is strongly twisted and S-shaped, with long, decurving apical spiculi and a subapical secondary gonopore, differing from species of *Occidentodema*, which have a nontwisted, weakly S-shaped vesica, with relatively short apical spiculi and an apical secondary gonopore.

Americodema and *Occidentodema* also are very similar in overall external appearance. All species are pale greenish white or golden yellow and all but one (*A. knighti*) possess black lines on the pro- and metafemora and antennal segments I and II and a black spot at the base of each tibia. Convergence is common in the Miridae, including, for example, *Plagiognathus ribesi* Kelton (Kelton 1982) and species of *Lineatopsallus* Henry (Henry 1991), which are also pale and have similar black lines and spots on the appendages. These taxa, however, have entirely different male genitalia and lack any trace of keels on the male genital capsule, indicating that they are not closely related to *Americodema* or *Occidentodema*.

The following key uses only external characters to separate genera and species. See the respective generic diagnoses for information on internal characters.

KEY TO THE SPECIES OF *AMERICODEMA* AND *OCCIDENTODEMA*

- 1. Mesofemur lacking a dorsal black line; pro- and metafemora with or without black lines (*Americodema*, n. gen.) 2
- All femora with distinct dorsal black lines (*Occidentodema*, n. gen.) 3
- 2. Apex of tylus with a distinct black spot; antennal segments I and II and pro- and metafemora with narrow black lines; widespread in eastern North America, west to Minnesota, Texas, and northern Mexico *A. nigrolineatum* (Knight)
- Apex of tylus and all appendages uniformly pale greenish white, lacking black markings; District of Columbia (Washington, DC) and Virginia, west to Missouri and Texas *A. knighti* Kerzhner and Schuh
- 3. Apex of tylus lacking a dark spot; overall body coloration golden yellow; Arizona, Texas, Utah, and northern Mexico *O. mcfarlandi*, n. sp.
- Apex of tylus with a distinct dark spot; overall coloration pale greenish white or golden yellow 4



Figs. 1-6. Scanning electron micrographs of *Americodemus knighti*. 1. Head and pronotum, lateral aspect (112 \times). 2. Ostiolar area (368 \times). 3. Male genital capsule, lateral aspect (179 \times). 4. Enlargement of genital keel, lateral aspect (690 \times). 5. Enlargement of genital keel, caudal aspect (740 \times). 6. Male genital capsule, caudal aspect (191 \times).

4. Coloration golden yellow; antennal segment II of male shorter than greatest width across hemelytra; Arizona *O. clypealis*, n. sp.
 – Coloration pale greenish white; antennal segment II of male distinctly longer than greatest width across hemelytra; Arizona, Colorado, New Mexico, and Utah. . . *O. polhemusi*, n. sp.

Americodemus knighti Kerzhner and Schuh, 1998, new combination

Figs. 1-6, 14-17

Plagiognathus albellus Knight 1953: 509; Carvalho 1958: 94; Henry and Wheeler 1988: 482; Wheeler 1995: 29; Schuh 1995: 381. Preoccupied by *Plagiognathus albella* Stichel 1934: 282.

Plagiognathus knighti Kerzhner and Schuh 1998: 171. New name for the preoccupied *P. albellus* Knight.

Diagnosis. Recognized by the uniformly pale greenish-white to pale greenish-yellow coloration.

Description. Male (N = 10): Length 3.32–3.64 mm, width 1.24–1.36 mm. Overall coloration of body and appendages pallid to pale greenish white, fading to pale greenish yellow in some preserved specimens; appendages uniformly pale. Pubescence, short, simple, pale, and recumbent. *Head* (Fig. 1): Width 0.68–0.72 mm, vertex 0.32–0.36 mm; uniformly pallid to pale greenish white. *Rostrum*: Length 1.20–1.28 mm, extending to apices of mesocoxae. *Antenna*: Segment I, length 0.28–0.30 mm; II, 1.00–1.12 mm; III, 0.60–0.72 mm; IV, 0.30–0.40 mm. *Pronotum*: Length 0.52–0.66 mm, basal width 1.04–1.08 mm. *Ostiole area*: Fig. 2.

Male genital capsule and median keel (Figs. 3–6); left paramere (Fig. 14); right paramere (Fig. 15); vesica (Fig. 16); phallosome (Figs. 17a, b).

Female (N = 10): Length 3.28–3.72 mm, width 1.24–1.28 mm. *Head*: Width 0.66–0.70 mm, vertex 0.36–0.38 mm. *Rostrum*: Length 1.18–1.34 mm, extending to apices of metacoxae. *Antenna*: Segment I, length 0.26–0.28 mm; II, 0.94–1.16 mm; III, 0.56–0.72 mm; IV, 0.32–0.34 mm. *Pronotum*: Length 0.48–0.52 mm, basal width 1.04–1.10.

Hosts. Sycamore, *Platanus occidentalis* L.; London plane, *P. x acerifolia* (Aiton) Willd. (Wheeler 1995).

Distribution. United States (Missouri, Texas, and Virginia) (Knight 1953, Wheeler 1995). Arkansas and the District of Columbia (Washington, DC) are new records.

Material examined. UNITED STATES: **Arkansas**: 1 ♀, Pulaski Co., 1 May '30, D. Isely (USNM). **District of Columbia** (Washington, D.C.): 1 ♂, May 31, 1918, H. B. Dietz, on sycamore (USNM). **Missouri**: ♂ holotype and 1 ♂ paratype (of *Plagiognathus albellus* Knight), St. Louis, VI-2, 16-1944, R. C. Froeschner (USNM). **Texas**: 4 ♂♂, 7 ♀♀, Jackson Co., nr. Port Lavaca, Rt. 35, 25 Apr. 1983, T. J. Henry and A. G. Wheeler, Jr., on *Platanus occidentalis* (USNM); 3 ♂♂, 1 ♀, Leon Co., 5.5 mi north of Flynn, May 14, 1997, A. R. Gillogly (TAM); 22 ♂♂, 49 ♀♀, Mason Co., 8.5 mi south Mason Llano River crossing, May 13, 1997, Gillogly and Schaffner, taken from sycamore (TAM, USNM); 5 ♂♂, 7 ♀♀, Uvalde Co., 9 mi west Utopia, May 1, 1983, J. C. Schaffner, ex. sycamore (nymphs) (TAM); 1 ♂, 2 ♂♂, Val Verde Co., 22.5 mi north Comstock Devil's River crossing, May 11, 1997, Gillogly and Schaffner (TAM); 2 ♂♂, 2 ♀♀, Travis Co., Rt. 29, Georgetown, along San Gabriel River, 5 May 1983, T. J. Henry, on *Platanus occidentalis* (USNM). **Virginia**: 10 ♂♂, 10 ♀♀, Albemarle Co., Univ. Virginia campus, Charlottesville, 29 May 1995, A. G. Wheeler, Jr., on *Platanus occidentalis* (USNM).

Americodema nigrolineatum (Knight), 1923, new combination
Figs. 7–13, 18–21

Macrotylus vestitus: Wirtner 1904: 201. Record clarified by Wheeler and Henry 1977: 150

Plagiognathus nigrolineatus Knight 1923: 443; Blatchley 1926: 928; Knight 1941: 26; Froeschner 1949; Khalaf 1971: 340

Icodema nigrolineata: Carvalho 1955: 226, 1958: 53; Schuh 1995: 326

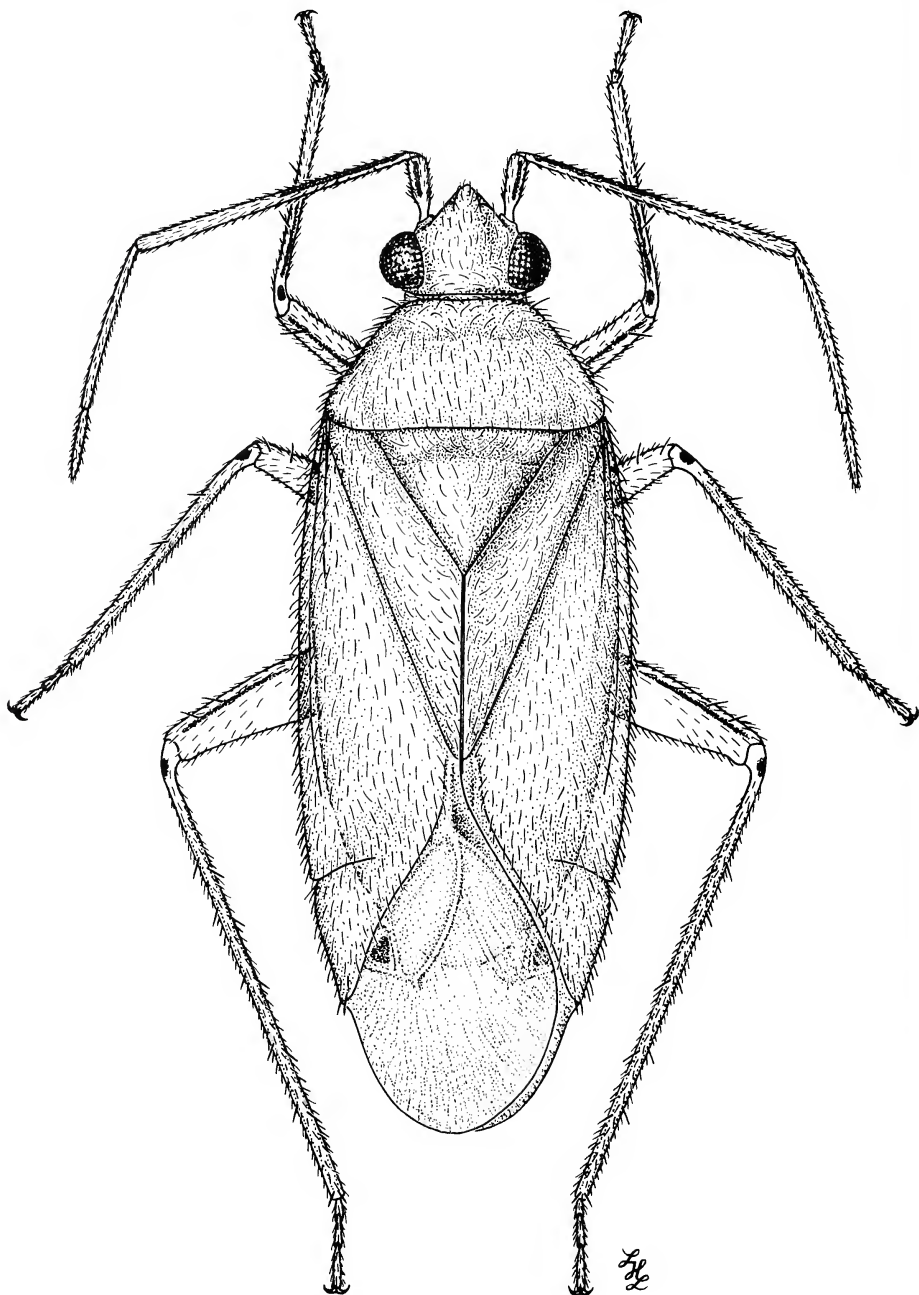


Fig. 7. Dorsal habitus of *Americodema nigrolineatum*.

Icodema nigrolineatum: Steyskal 1973: 206; Henry and Smith 1979: 213; Kelton 1980: 292; Henry and Wheeler 1988: 468

Diagnosis. Recognized by the presence of a fuscous spot at the apex of the tylus and the relatively large fuscous spot (subequal in size to a knee spot) on the anterior apical $\frac{1}{3}$ of the metafemur. *Americodema nigrolineatum* is similar to *Occidentodema polhemusi* in size and pale greenish-white coloration, but can be separated by the presence of a large subapical metafemoral spot, the shorter second antennal segment that is shorter than the widest area across the hemelytra, and the lack of a black line on the dorsal edge of the mesofemur.

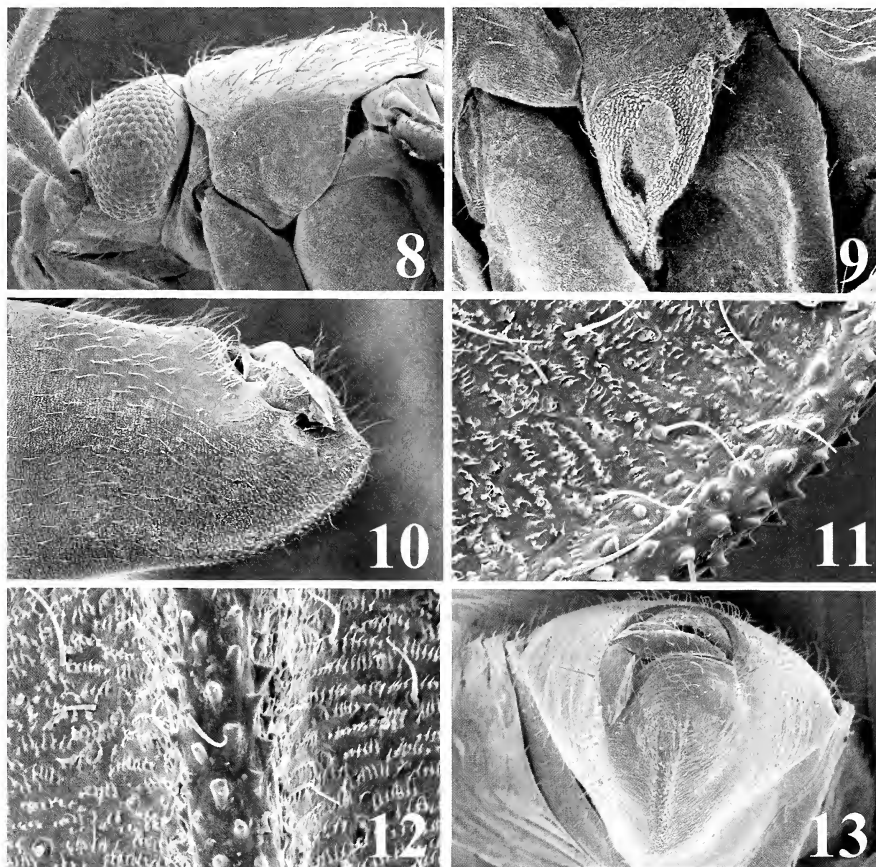
Description. Male (N = 10): Length 3.68–4.40 mm, width 1.36–1.52 mm. Overall coloration pallid to pale greenish white, turning more yellowish in preserved specimens. *Head* (Fig. 8): Width 0.74–0.82 mm, vertex 0.34–0.36 mm; uniformly pale greenish white, with a fuscous spot at the apex of the tylus. *Rostrum*: Length 1.42–1.50 mm, extending to bases of metacoxae. *Antenna*: Segment I, length 0.28–0.32 mm, with an indistinct subapical spot on inner surface and two fuscous stripes, the ventral one extending from base to near apex and the dorsal one occupying middle $\frac{1}{2}$ of segment; II, 1.22–1.40 mm, yellow with a narrow fuscous stripe extending to middle from base; III, 0.68–0.76 mm; IV, 0.34–0.36 mm. *Pronotum*: Length 0.56–0.66 mm, basal width 1.12–1.36 mm. Hemelytra pale to pale greenish white, corium more translucent; membrane translucent white, small areole often infuscated. *Ostiole area*: Fig. 9. Legs pale; profemur with an indistinct fuscous, dorsal stripe on apical $\frac{1}{3}$, mesofemur uniformly pale, occasionally with a short subapical stripe on posterior face, metafemur with two fuscous stripes, an indistinct, sometimes spotted one dorsally on apical $\frac{1}{2}$ and a more distinct one ventrally on apical $\frac{1}{2}$, anterior face with a single, relatively large fuscous spot at middle of apical $\frac{1}{3}$; each tibia with a distinct fuscous knee spot, metatibia often with indistinct fuscous spots at bases of basal 3 or 4 spines.

Male genital capsule and median keel (Figs. 10–13); left paramere (Fig. 18); right paramere (Fig. 19); vesica (Fig. 20); phallosome (Fig. 21a, b).

Female (N = 10): Length 4.00–4.32 mm, width 1.56–1.68 mm. *Head*: Width 0.38–0.40 mm, vertex 0.76–0.78 mm. *Rostrum*: Length 1.52–1.54 mm, extending to bases of metacoxae. *Antenna*: Segment I, length 0.30–0.32 mm; II, 1.32–1.38 mm; III, 0.64–0.72 mm; IV 0.30–0.32 mm. *Pronotum*: Length 0.62–0.64 mm, basal width 1.32–1.34 mm.

Hosts. This species has been previously recorded from bur oak, *Quercus macrocarpa* Michx. (Knight, 1923, 1941), and live oak, *Q. virginiana* Mill. (Blatchley, 1926). A. G. Wheeler and I have collected *A. nigrolineatum* in abundance on post oak, *Q. stellata* Wangenh., in Texas, and J. A. Slater reared it from *Q. rubrum* in Iowa. It also disperses as adults to other flowering plants, probably accounting for the *Rhus glabra* record listed in the "specimen examined" data. D. Polhemus' (1994) record of this species on Gambel's oak is referred to *O. polhemusi* Henry.

Distribution. *A. nigrolineatum* was previously known from Canada (Manitoba) and much of eastern United States (Connecticut, Florida, Georgia, Illinois, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, and Texas) (Henry and Smith, 1979; Henry and Wheeler, 1988). Polhemus (1994) Colorado record is here referred to *A. polhemusi* Henry. New U. S. state records for this species are Iowa, North Carolina,



Figs. 8-13. Scanning electron micrographs of *Americodema nigrolineatum*. 8. Head and pronotum, lateral aspect (107 \times). 9. Ostiolar area (268 \times). 10. Male genital capsule, lateral aspect (164 \times). 11. Enlargement of genital keel, lateral aspect (985 \times). 12. Enlargement of genital keel, caudal aspect (1780 \times). 13. Male genital capsule, caudal aspect (144 \times).

Oklahoma, Tennessee, and Virginia. Ontario is a new province record for Canada. Nuevo Leon and San Luis Potosi represent the first records for Mexico.

Material examined. CANADA: **Ontario:** 1 ♀, Ottawa 3-VII-1904, W. Metcalfe, oak (AMNH). MEXICO: **Nuevo Leon:** 3 ♀♀, 7 mi S Monterrey, Apr. 17, 1978, J. C. Schaffner, on live oak (TAM). **San Luis Potosi:** 1, ♂, 3 ♀♀, 2 mi E of Ciudad del Maiz, Apr. 12, 1979, T. P. Friedlander and J. C. Schaffner, taken from *Quercus sideroxyla* Humbolt & Bonpland [plant det K. Nixon '88](TAM). UNITED STATES: **Connecticut:** 1 paratype ♀, Orange, 22 June 1920, B. H. Walden (USNM). FLORIDA: 3 ♂♂, 1 ♀, Sanford, March 15, 1927, E. D. Ball (USNM). **Georgia:** 1 ♂, Atlanta, 5-6-43, P. W. Fattig (USNM). **Iowa:** 2 ♀♀, Ames, V-28-1951, J. A. Slater, reared from *Quercus rubrum* (AMNH). **Minnesota:** 1 ♂, 6 ♀♀ (including 5 paratypes), Anoka Co., June 11, 1920, H. H. Knight (USNM); 8 ♂♂, 5 ♀♀ (paratypes),

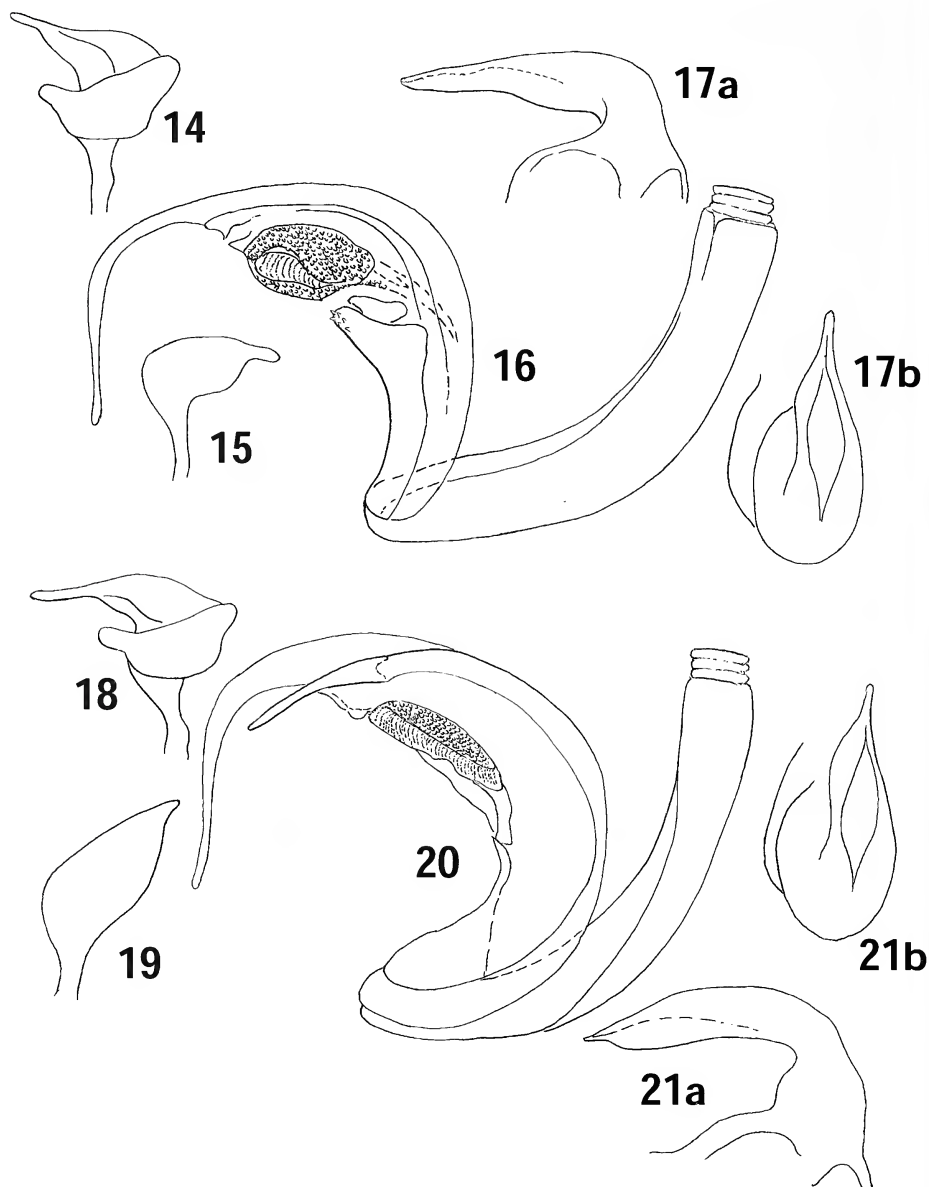
St. Anthony Park, June 10, 1920, H. H. Knight (USNM); 54 ♂♂, 43 ♀♀ [plus many other specimens, including paratypes, from this locality], St. Anthony Park, June 6–11, 1923 & July 1, 1924, H. H. Knight (USNM); 3 ♂♂, 2 ♂♂ (paratypes), Lakeland, June 14, 1922, H. H. Knight (USNM). **Missouri:** 1 ♂, Marston, May 10, 1942, R. C. Froeschner (USNM). **North Carolina:** 1 ♀, Mecklenburg Co., Rt 51, 1 mi W. of Rt. 16, nr Matthews, 26 Apr. 1976, A. G. Wheeler, Jr., taken on *Quercus stellata* (AMNH). **Oklahoma:** 1 ♀, Tuskahoma, 5-23-28, R. H. Beamer (Kansas University). **Tennessee:** 5 ♂♂, 2 ♀♀, Hamilton Co., May 10, 1943, Turner, light at edge of peach orchard (USNM). **Texas:** 1 ♂, Brazos Co., April 14, 1931, R. K. Fletcher (USNM); 6 ♂♂, 1 ♀, Brazos Co., Bryan, March 30–31, 1967, April 10–16, 1967–72, at light, J. C. Schaffner (USNM); 1 ♂, 1 ♀, Brazos Co., College Station, H. G. Johnston, April 5–11, 1928, at light (USNM); 1 ♀, Brazos Co., College Station, April 30, 1930, no collector (USNM); 1 ♂, 5 ♀♀, Brazos Co., College Station, Apr. 15, 1978, T. J. Henry, J. C. Schaffner, and R. T. Schuh, taken on *Quercus virginiana* (AMNH); 7 ♂♂, 6 ♂♂, Brazos Co., College Station, 29–30 Apr. 1983, T. J. Henry and A. G. Wheeler, Jr., taken on *Quercus stellata* (USNM). **Virginia:** 1 ♀, Dyke, May 28, 1915, W. L. McAtee, on *Rhus glabra* (USNM); 1 ♂, 1 ♀, Mountain L., July 22, 1940, L. J. and M. J. Milne (USNM).

Occidentodema, new genus

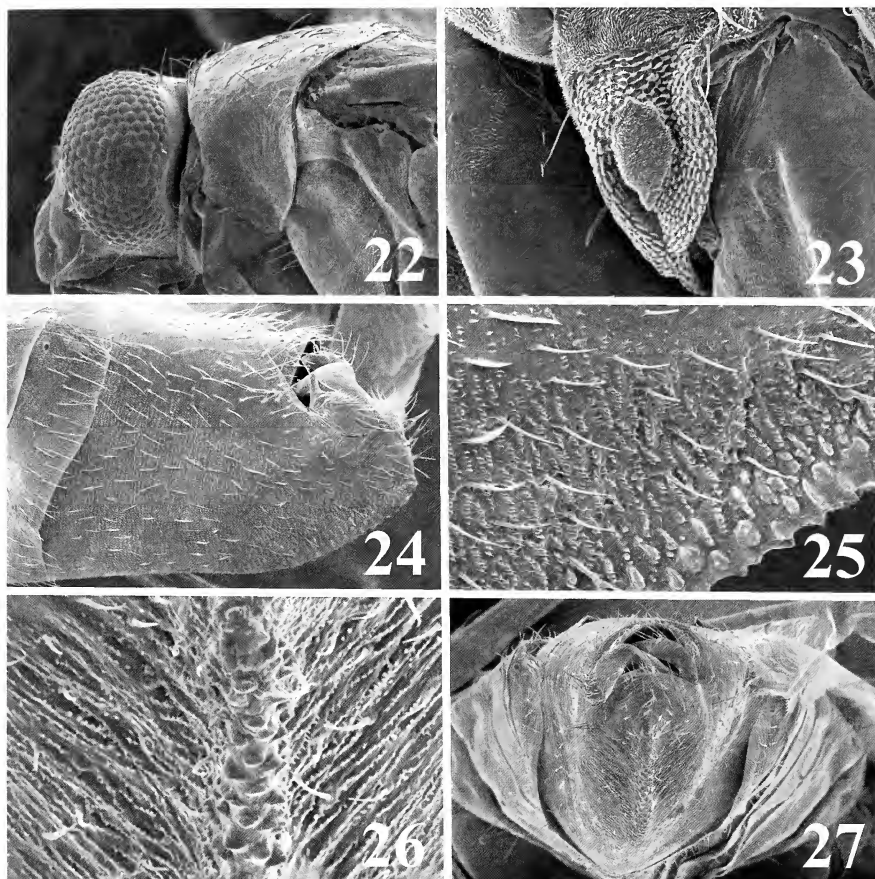
Type species. *Occidentodema mcfarlandi* Henry, new species.

Diagnosis. Species pale greenish white to golden brown, with a distinct black dorsal line on each femur; vesica of male weakly S-shaped (Figs. 44, 48, 52), but not twisted, apex with a slender, relatively short spiculum, sometimes with a very small second spiculum, and the secondary gonopore apical.

Description. Length 2.88 to 4.44 mm. Elongate, oval. General coloration pale greenish white to golden brown, with distinct fuscous lines and spots on the legs and antennae. Head much broader than long; eyes prominent, granulate, more so in males; vertex less than $\frac{1}{2}$ the width of head in males, subequal to $\frac{1}{2}$ in females. Rostrum extending to metacoxae; length of segments I, II, and IV subequal, segment III slightly shorter. Antennae slender, length ranging from 0.68–0.90 the length of body in ♂♂, from 0.65–0.69 in ♀♀; segment I shortest, stoutest; segment II longest, segment III ranging from 0.53–0.67 the length of II in ♂♂, from 0.61–0.67 in ♀♀; segment IV slightly longer than I. Pronotum trapeziform, about two times wider at base than median length; scutellum equilateral. Hemelytra subparallel, opaque to translucent, particularly on corium; pubescence short, simple, recumbent; membrane translucent with two distinct areoles. Legs slender; each femur with a narrow dorsal fuscous line, often marked with small spots on the anterior face of the metafemur; each tibia with black knee spot and a narrow black line on basal half, tibial spines lacking dark spots at bases, metatibia sometimes with a few indistinct dark spots at bases of basal spines; claws with hairlike parempodia. Male genital capsule with a distinct median keel ventrally (Figs. 24–27, 30–33, 37–41), extending from base of segment to truncated caudal area just below aperture; left (Figs. 42, 46, 50) and right (Figs. 43, 47, 51) parameres typically phyline; vesica (Figs. 44, 48, 52) stout, weakly S-shaped with a large, distinct, apical secondary gonopore; phallosome (Figs. 45, 49, 53) slender, narrowly tapered to apex, without lateral notch or tooth.



Figs. 14-21. Male genitalia of *Americodema* spp. 14-17, *A. knighti*. 14. Left paramere. 15. Right paramere. 16. Vesica. 17a. Phallosome, lateral aspect. 17b. Phallosome, dorsal aspect. 18-21, *A. nigrolineatum*. 18. Left paramere. 19. Right paramere. 20. Vesica. 21a. Phallosome, lateral aspect. 21b. Phallosome, dorsal aspect.



Figs. 22–27. Scanning electron micrographs of *Occidentodema clypealis*. 22. Head and pronotum, lateral aspect (129 \times). 23. Ostiolar area (214 \times). 24. Male genital capsule, lateral aspect (177 \times). 25. Enlargement of genital keel, lateral aspect (640 \times). 26. Enlargement of genital keel, caudal aspect (735 \times). 27. Male genital capsule, caudal aspect (158 \times).

Etymology. The generic name *Occidentodema* is created from the Latin “occidentalis,” meaning of the west, and the suffix from the root of the generic name *Icodema* to reflect the historical association of this genus to *Americodema* and the Palearctic *Icodema infuscatum*. Like *Americodema* and *Icodema*, the gender is interpreted as neuter, following Steyskal (1973).

Discussion. Generic relationships are discussed in the discussion under the generic description of *Americodema*.

***Occidentodema clypealis*, new species**

Figs. 22–27, 42–45

Diagnosis. Recognized by the combination of its small size, the overall pale yellowish coloration, with a golden to orange tinge on the head and pronotum, the rosaceous

tinge along the side of the abdomen, the fuscous spot at the apex of the tylus, and by the distinct dorsal stripe on each femur. *Occidentodema clypealis* is similar to *O. polhemusi* and *Americodema nigrolineatum* in having a black spot on the apex of the tylus, but can be separated from *O. polhemusi* by the shorter second antennal segment that is less than the width across the hemelytra, and from *A. nigrolineatum* by the shorter body length, golden-yellow coloration and the distinct fuscous dorsal stripe on the mesofemur.

Description. Male (N = 10): Length 3.16–3.52 mm, width 1.20–1.22 mm. Overall coloration pale yellow, with the head and pronotum accented with gold or orange. Dorsal pubescence short, recumbent, pale golden yellow. *Head* (Fig. 22): Width 0.72–0.74 mm, vertex 0.26–0.30 mm; uniformly pale yellow, tinged with orange on frons and tylus; apex of tylus with a distinct black spot. *Rostrum*: Length 1.10–1.18 mm, extending to apices of metacoxae. *Antenna*: Segment I, length 0.24–28 mm; II, 1.08–1.18 mm; III, 0.60–0.62 mm; IV, 0.24–0.30 mm; overall coloration golden yellow; segment I with two distinct fuscous stripes extending entire length, one ventrolateral and the other more dorsal along inner margin; II, brownish yellow, with a short fuscous stripe at base, this stripe sometimes extending nearly to middle of segment as a very narrow reddish line; segments III and IV brownish. *Pronotum*: Length 0.44–0.48 mm, basal width 0.96–1.04 mm. Hemelytra pale golden yellow, tinged with pale brown, membrane pale translucent whitish, accented with pale golden brown, particularly inside small areole, area bordering veins, and apex. *Ostiole area*: Fig. 23. Abdomen pale yellow, basal two segments ventrally and a broad stripe laterally rose colored or red. Legs slender, pale yellow; each femur with a fuscous stripe extending from apex to about middle along dorsal margin, metafemur also with a shorter fuscous stripe ventrally on apical $\frac{1}{4}$ and a few small, indistinct spots on anterior face; each tibia with a distinct fuscous knee spot and a narrow fuscous stripe on basal $\frac{1}{3}$ to $\frac{1}{4}$, metatibia usually with indistinct fuscous spots at bases of spines.

Male genital capsule and median keel (24–27); left paramere (Fig. 42); right paramere (Fig. 43); vesica (Fig. 44); phallosome (Fig. 45).

Female (N = 8): Length 2.88–3.20 mm, width 1.26–1.40 mm. *Head*: Width 0.66–0.68 mm, vertex. *Rostrum*: Length 1.12–1.20 mm, extending to bases of metacoxae. *Antenna*: Segment I, length 0.24–0.26 mm; II, 0.86–0.96 mm; III, 0.58–0.60 mm; IV, 0.26–0.28 mm. *Pronotum*: Length 0.46–0.48 mm, basal width 1.02–1.04 mm.

Etymology. Named “clypealis” to emphasize the fuscous spot at the apex of the clypeus or tylus.

Host. Taken on *Quercus reticulata* Humbolt & Bonpland and Shrub live oak, *Quercus turbinella* Greene. I note that the small series taken on *Q. reticulata* Humbolt & Bonpland in Arizona, was collected along with a much larger series of *O. polhemusi* (all females).

Distribution. United States (Arizona).

Types. Holotype, ♂, UNITED STATES: **Arizona**: Gila Co., 8 mi SW Jct. of Rts 87 & 188 (off Rt. 87), Tonto Nat'l For., 4,000 ft, May 27–28 1983, R. Schuh and G. Stonedahl, ex. mercury vapor light (AMNH). Paratypes: UNITED STATES: **Arizona**: 1 ♂, 4 ♀♀, Cochise Co., 1.5 mi towards Portal from Onion Saddle, 2,350 m, June 13, 1980, RT Schuh, K & R Schmidt, ex. *Quercus reticulata* Humb. & Bonpl. (AMNH); 53 ♂♂, 3 ♀♀, same data as for holotype (AMNH, 8 USNM); 3 ♂♂, 2 ♀♀, Gila Co., Old CCC Campgrd. S. of Globe on Pioneer Pass Rd., 4,700 ft,

May 30–31, 1983, R. T. Schuh, G. M. Stonedahl, and B. M. Massie, collected at light on white sheet attracted by mercury vapor lamp (AMNH); 3 ♂♂, 2 ♀♀, Maricopa Co., Salt R. Can., at Apache Lake, 2,000', IV-28-81, D. A. & J. T. Polhemus (JTPC); 2 ♂♂, Maricopa Co., Sunflower, CL1666, VI-2-81, J. T. Polhemus (JTPC); 1 ♀, Yavapai Co., 4 mi S. of Prescott Nat. For. Boundary S. of Prescott, \pm 1,600 m, June 20, 1980, R.T. Schuh, ex *Quercus turbinella* Greene (AMNH); 5 ♂♂, 6 ♀♀, Yavapai Co., 1 mile South of Yarnell on Rt. 89, June 3, 1983, G. M. Stonedahl, taken on *Quercus turbinella* Greene (Fagaceae) (AMNH; 2 USNM).

***Occidentodema mcfarlandi*, new species**

Figs. 28–35, 46–49

Diagnosis. Recognized by the overall pale golden-yellow coloration, the lack of a fuscous spot on the tylus, the numerous, small fuscous spots on the femora, particularly the metafemur, and by the strong fuscous lines along the dorsal margin of each femur. *Occidentodema mcfarlandi* is most similar to *O. clypealis* in size and general golden-yellow coloration, but is readily separated by the lack of a fuscous spot at the apex of the tylus.

Description. Male (N = 10): Length 3.28–3.88 mm, width 1.30–1.38 mm. Overall coloration pale golden yellow. Dorsal pubescence short, simple, golden yellow, and recumbent. *Head* (Fig. 28): Width 0.76–0.80 mm, vertex 0.30–0.32 mm; uniformly pale golden yellow. *Rostrum*: Length 1.32–1.44 mm, extending to apices of mesocoxae or bases of metacoxae. *Antenna*: Segment I, length 0.30–0.32 mm; II, 1.42–1.46 mm; III, 0.90–0.92 mm; IV, 0.32–0.38 mm; overall coloration pale to golden yellow; segment I with two distinct, fuscous stripes, one on ventral surface extending from apex to base, more lateral one extending from apex to about $\frac{3}{4}$ distance to base; segment II with an elongate fuscous spot at base, usually no longer than diameter of segment, sometimes diffusing into a more elongate stripe. *Pronotum*: Length 0.56–0.58 mm, basal width 1.12–1.14 mm. Hemelytra and membrane uniformly translucent pale golden yellow, middle of basal edge and small areole infuscated. *Ostiolar area*: Figs. 29, 30. Legs slender, pale yellow; pro- and mesofemora with a distinct, fuscous line extending from apex to midway along dorsal margin; metafemur with both a dorsal and ventral line, the dorsal one extending over apical $\frac{1}{2}$ and ventral ones along apical $\frac{1}{3}$; each tibia with a distinct fuscous knee spot and a narrow fuscous line extending from base to about midway on each segment; a few basal spines on metatibia bearing indistinct dark spots; claw (Fig. 35).

Male genital capsule and median keel (Figs. 31–34); left paramere (Fig. 46); right paramere (Fig. 47); vesica (Fig. 48); phallosome (Figs. 49a, b).

Female (N = 10): Length 3.24–3.84 mm, width 1.40–1.56 mm. *Head*: 0.70–0.76 mm, vertex 0.34–0.36 mm. *Rostrum*: Length 1.30–1.42 mm, extending to apices of mesocoxae. *Antenna*: Segment I, length 0.28–0.30 mm; II, 1.02–1.12 mm; III, 0.62–0.76 mm; IV, 0.30–0.32 mm. *Pronotum*: Length 0.54–0.60 mm, basal width 1.18–1.26 mm.

Etymology. This species is named in honor of Noel McFarland (Hereford, AZ) in appreciation of his numerous donations of Arizona Miridae to the USNM, including large series of *A. mcfarlandi*, and for his local hospitality while performing fieldwork in the Huachuca Mountains of southeastern Arizona.

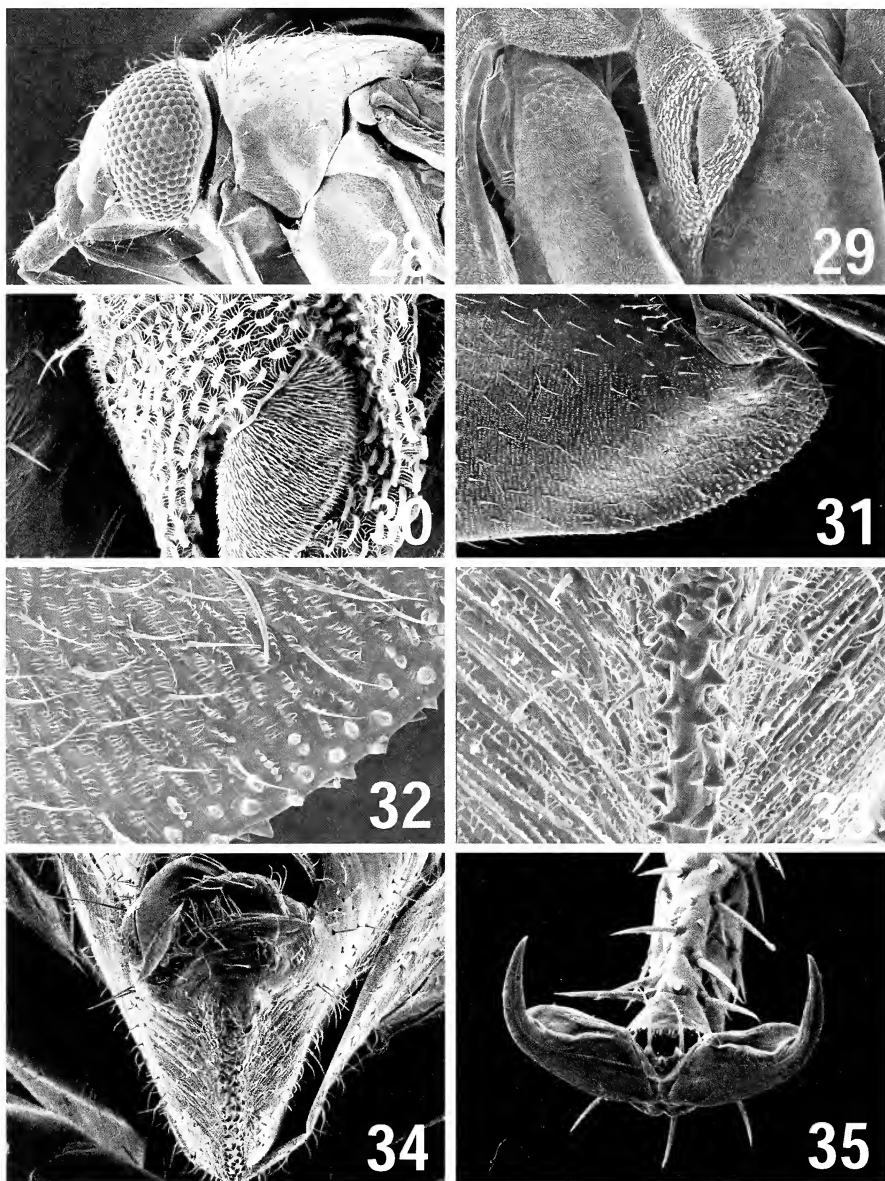
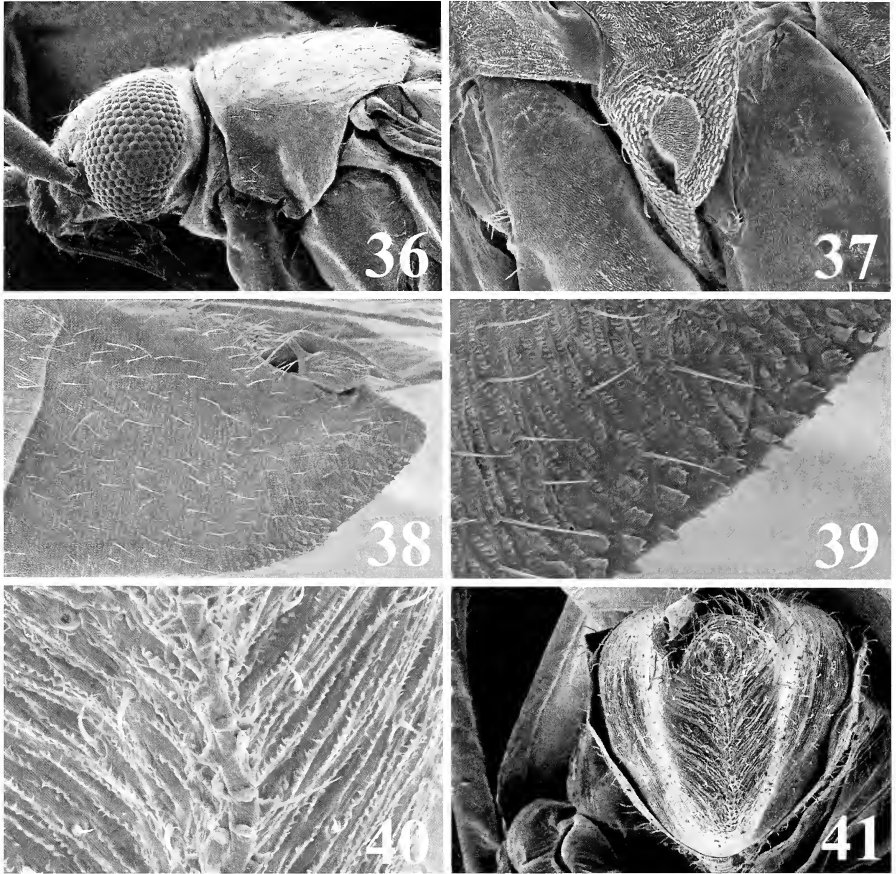


Fig. 28–35. Scanning electron micrographs of *Occidentodema mcfarlandi*. 28. Head and pronotum, lateral aspect (110 \times). 29. Ostiolar area (280 \times). 30. Enlargement of ostiolar area (900 \times). 31. Male genital capsule, lateral aspect (208 \times). 32. Enlargement of genital keel, lateral aspect (655 \times). 33. Enlargement of genital keel, caudal aspect (825 \times). 34. Male genital capsule, caudal aspect (212 \times). 35. Pretarsal claw (700 \times).

Hosts. Arizona white oak, *Quercus arizonica* Sarg.; Emory's oak, *Q. emoryi* Torr.; Gambel's oak, *Q. gambelii* Nutt.; Mexican blue oak, *Q. oblongifolia* Torr.; shrub live oak, *Q. turbinella* Greene; rocky mountain scrub oak, *Q. undulata* Torr.; *Quercus* sp.

Distribution. Mexico (Aguascalientes, Sonora) and the United States (Arizona, Texas, and Utah).

Types. Holotype ♂, UNITED STATES: **Arizona:** Cochise Co., Huachuca Mts., 5334 Ash Cyn. Rd., 0.5 mi W Hwy 92, el. 5,100 ft, 29 Apr. 1993, at UV light, N. McFarland (USNM). Paratypes: MEXICO: **Aguascalientes:** 7 ♂♂, 1 mile east Calvillo, July 11, 1983, take at blacklight, Kovarik, Harrison, Schaffner (5 TAM, 2 USNM). **Sonora:** 2 ♂♂, 2 ♀♀, 11 mi E. Maicova, IV-26-82, D. A. and J. T. Polhemus, on *Quercus* sp. (JTPC). UNITED STATES: **Arizona:** 56 ♂♂, 42 ♀♀, same data as for holotype, with following range of dates: 26 April to 17 June 1992–1993 (USNM); 1 ♂, Cochise Co., Portal, 4,770', IV-28-81, D. A. and J. T. Polhemus, on *Quercus emoryi* (Emory oak) (JTPC); 61 ♂♂, 43 ♀♀, Cochise Co., vicinity of Portal, 1,500–1,700 meters, May 2–7, 1978, R. T. Schuh, taken on *Quercus emoryi*, *Quercus oblongifolia* Torr., and *Quercus* sp. (Fagaceae) (AMNH); 18 ♂♂, 8 ♀♀, Cochise Co., Onion Saddle W to 3.5 mi E Nat. For. Bndry, Chiricahua Mts., 5,300–5,600 ft, 6/3/1983, R. T. Schuh and G. M. Stonedahl, on *Quercus oblongifolia* Torr (AMNH); 8 ♀♀, Cochise Co., Road from Portal-Rustler Park, Chiricahua Mts., 6,500 ft, June 2, 1983, R. T. Schuh and G. M. Stonedahl, on *Quercus undulata* Torr. (Fagaceae) (AMNH); 5 ♂♂, 6 ♀♀, Gila Co., 2 mi SE of Gila Co. line (4 mi. NE of Strawberry) on Rt. 87, 6,500 ft, June 15, 1983, R. T. Schuh and M. D. Schwartz, on *Quercus arizonica* Sarg. (Fagaceae) (AMNH); 1 ♂, 4 ♀♀, Gila Co., 8 mi SW Jct. of Rts. 87 & 188 (off Rt. 87 at Rd. 171), Tonto Nat'l For., 4,000, May 27–28, 1983, R. Schuh and G. M. Stonedahl, on *Quercus turbinella* Greene (Fagaceae) (AMNH); 17 ♂♂, 16 ♀♀, Graham County, Stockton Pass, Pinaleno Mts., elv. 5,200–5,500 ft, June 1–2, 1983, R. T. Schuh and G. M. Stonedahl, ex. Mercury vapor light (AMNH); 6 ♂♂, 22 ♀♀, Mohave Co., Hualapi Mts., SE Kingman, T20N R15W, 4,000–6,400 ft, June 9–10, 1983, R. T. Schuh, M. D. Schwartz, and G. M. Stonedahl, *Quercus tubinella* Greene (AMNH); 7 ♂♂, 10 ♀♀, Navajo Co., 15–20 miles SW Show Low, 5,200–6,000 ft., May 30, 1983, R. T. Schuh, G. M. Stonedahl, and B. M. Massie, *Quercus* cf. *arizonica* Sarg. (AMNH); 1 ♂, Pima Co., Santa Rita Mtns, Madera Can., V-25-82, CL103, C. N. McKinnan, on *Quercus* sp. (JTPC); 10 ♂♂, 12 ♀♀, Pima Co., Santa Catalina Mts., Molino Basin Camp Grounds, 8 April 1989, T. J. Henry and A. G. Wheeler, Jr., taken on *Quercus oblongifolia* (USNM); 7 ♂♂, 2 ♀♀, Pima Co., Sabino Cany. Baboquivari Mtns., IV-20-82, D. A. and J. T. Polhemus, *Quercus arizonica* (Arizona white oak) (JTPC); 11 ♂♂, 25 ♀♀, Yavapai Co., 15.8 miles south of Ash Fork on Rt. 89, June 4, 1983, G. M. Stonedahl, *Quercus turbinella* (AMNH); 35 ♀♀, Yavapai Co., 4 mi S of Prescott Nat. For. Boundary S of Prescott, ± 1,600 m, June 20, 1980, R. T. Schuh, on *Quercus turbinella* Greene (Fagaceae) (AMNH). **Texas:** 5 ♂♂ [Brewster], Alpine, May 5, 1927, J. O. Martin (CAS); 11 ♂♂, 32 ♀♀, Culberson Co., just N. of Guadalupe Mts. Nat'l. Pk., 1,660 m, Apr. 28, 1978, R. T. Schuh (ANMH); 2 ♂♂, 4 ♀♀, Jeff Davis Co., Davis Mtns., 3 mi W Ft. Davis, IV-30-82, D. A. and J. T. Polhemus, on *Quercus emoryi* (Emory oak) (JTPC); 13 ♂♂, 15 ♀♀, Pecos Co., 45 miles southeast of Ft. Stockton, April 17, 1985, J. C. Schaffner coll. (TAM, USNM); 1 ♀, Pecos Co., 36 mi. S. Ft. Stockton, 4,500', V-2-82, D.A. & J.T. Polhemus, on *Quercus* sp. (JTPC). **Utah:** 1 ♂, 6



Figs. 36–41. Scanning electron micrographs of *Occidentodema polhemusi*. 36. Head and pronotum, lateral aspect (106 \times). 37. Ostiolar area (440 \times). 38. Male genital capsule, lateral aspect (161 \times). 39. Enlargement of genital keel, lateral aspect (625 \times). 40. Enlargement of genital keel, caudal aspect (960 \times). 41. Male genital capsule, caudal aspect (155 \times).

♀ ♀, Washington Co., Zion National Park, 7 mi NE St. Rt. 15 on Kolob Rsrv. Rd., 4,000–5,000 ft, May 25, 1981, M. D. Schwartz, on *Quercus gambelii* Nutt. (Fagaceae) (AMNH).

***Occidentodema polhemusi*, new species**

Figs. 36–41, 50–53

Icodema nigrolineatum: D. Polhemus 1994: 130.

Diagnosis. This species is recognized by the combination of its relatively large size, second antennal segment that is longer than the width across the hemelytra, the overall pale greenish-white coloration, the fuscous spot at the apex of the tylus and the distinct dorsal stripe on each femur. *Occidentodema polhemusi* is most similar

to *Americodema nigrolineatum* in the larger general size and overall pale greenish-white coloration, but can be separated by the much longer second antennal segment and the one to three small fuscous spots on the anterior face of the metafemur.

Description. Male (N = 10): Length 3.83–4.44 mm, width 1.32–1.40 mm. Overall coloration pallid to pale greenish white. *Head* (Fig. 36): Width 0.76–0.80 mm, vertex 0.30–0.32 mm; pallid to pale greenish white, apex of tylus with a fuscous or black spot. *Rostrum*: Length 1.38–1.52 mm, extending to bases of metacoxae. *Antenna*: Segment I, length 0.32–0.36 mm; II, 1.52–1.64 mm; III, 1.00–1.10 mm; IV, 0.38–0.42 mm. *Pronotum*: Length 0.48–0.56 mm, basal width 1.00–1.08 mm. Hemelytra pallid to pale greenish white, corium more translucent; membrane translucent with a whitish cast, area inside small areole infuscated. *Ostiolar area*: Fig. 37. Legs pale; each femur with a fuscous dorsal stripe on apical $\frac{1}{2}$ to $\frac{2}{3}$, meso- and metafemora also with a shorter ventral stripe on apical $\frac{1}{4}$; anterior face of metafemur with one or two small fuscous spots on apical $\frac{1}{3}$; each tibia with a large fuscous knee spot and a fuscous stripe on basal $\frac{1}{3}$ to $\frac{1}{2}$, metatibia with small fuscous spots at bases of spines.

Male genital capsule and median keel (Figs. 38–41); left paramere (Fig. 50); right paramere (Fig. 51); vesica (Fig. 52); phallosome (Fig. 53).

Female (N = 10): Length 3.66–4.00 mm, width 1.40–1.44 mm. *Head*: Width 0.68–0.70 mm, vertex 0.32–0.34 mm. *Rostrum*: Length 1.36–1.38 mm. *Antenna*: Segment I, length 0.28–0.32 mm; II, 1.16–1.20 mm; III, 0.78–0.80 mm; IV, 0.32–0.38 mm. *Pronotum*: Length 0.52–0.54 mm, basal width 1.14–1.16 mm.

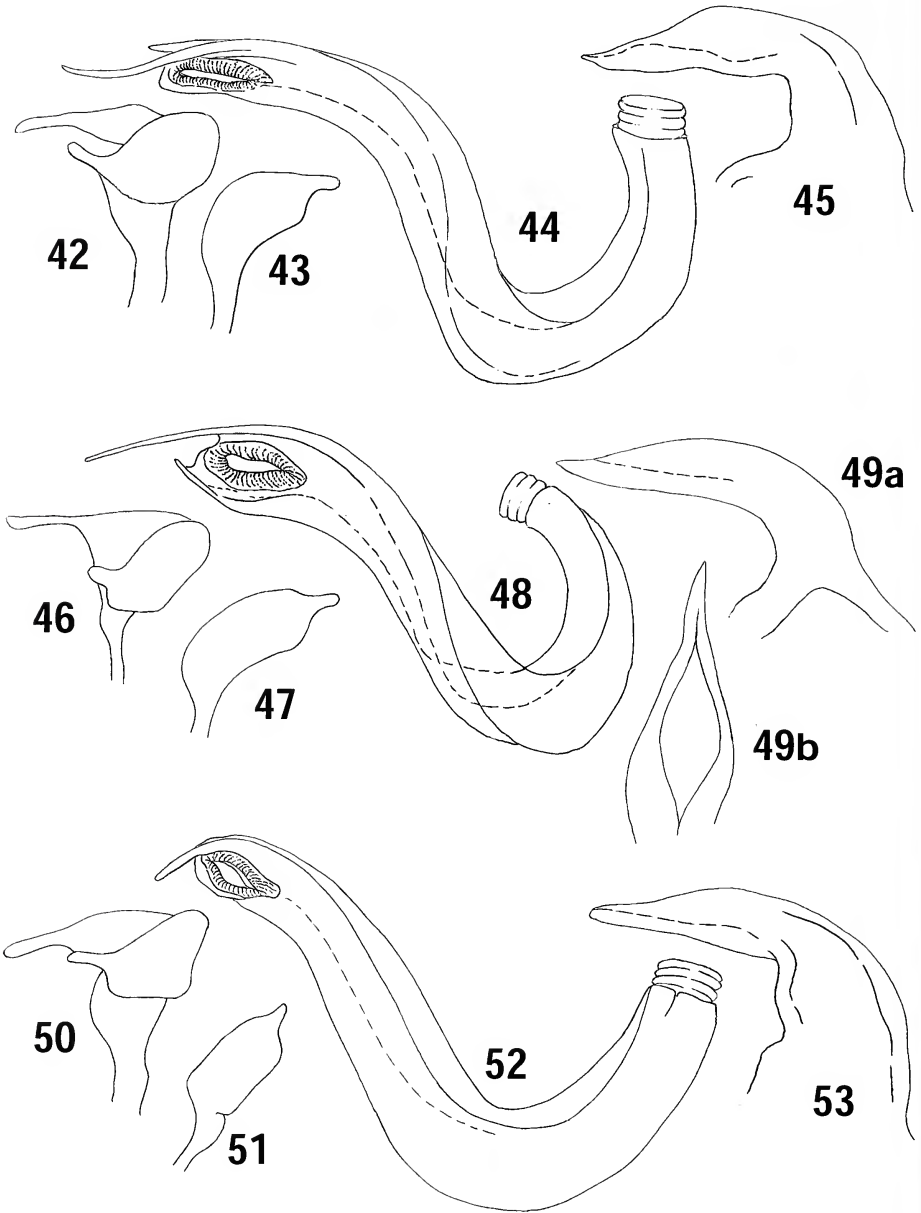
Etymology. This species is named in honor of my long-time friend and colleague, Dr. John T. Polhemus, on the occasion of his 70th birthday, who also collected many specimens used in the description of this new species, including the holotype.

Host. Found most commonly on Gambel's oak, *Quercus gambelii* Nutt. A small series from Sevier Co., Utah, is labeled from *Artemisia* sp., indicating a possible error or a case of dispersing adults to the inflorescences of *Artemisia*.

Distribution. United States (Arizona, Colorado, New Mexico, and Utah).

Discussion. In April 1989, A. G. Wheeler, Jr. and I collected 23 specimens (only 5 of which were males) on Arizona sycamore, *Platanus wrightii* S. Watson, in Madera Canyon, Pima Co., Arizona. These specimens are very similar to *O. polhemusi* in general appearance, shape of the male genital capsule, and the male vesica, but all lack the distinct black spot at the apex of the tylus, a marking that is consistently present or absent in all other species. The teneral condition of several specimens might explain the absence of the characteristic black spot, and it is also possible the entire series was accidental on sycamore, although no specimens were taken on *Quercus* at this locality. Until additional material is collected to show otherwise, I consider this series to represent *O. polhemusi*.

Types. Holotype, ♂, UNITED STATES: **New Mexico**: Sandoval Co., Jemez Mtns., 10 mi W. Los Alamos, VII-4-[19]82, D. A. & J. T. Polhemus colls., taken on *Quercus gambelii* (Gambel oak) (USNM). Paratypes: UNITED STATES: **Arizona**: 42 ♀♀, Cochise Co., 1.5 mi towards Portal from Onion Saddle, 2,350 m, June 13, 1980, RT Schuh, K & R. Schmidt, ex. *Quercus reticulata* Humb. & Bonpl. (AMNH); 1 ♀, [Coconino Co.], Grand Canyon, Alt. 7,000', June 22, 1925, A. A. Nichol (USNM); 2 ♂♂, 3 ♀♀, [Coconino Co.], Williams, Alt. 7,000', June 15, 1925, A. A. Nichol (USNM) 4 ♂♂, 7 ♀♀ [Coconino Co.], Grand Canyon, S. Rim, VI-24-1930, R. L.



Figs. 42-53. Male genitalia of *Occidentodema* spp. 42-45, *O. clypealis*. 42. Left paramere. 43. Right paramere. 44. Vesica. 45. Phallosome. 46-49. *O. mcfarlandi*. 46. Left paramere. 47. Right paramere. 48. Vesica. 49a. Phallosome, lateral aspect. 49b. Phallosome, dorsal aspect. 50-53. *O. polhemusi*. 50. Left paramere. 51. Right paramere. 52. Vesica. 53. Phallosome, lateral aspect.

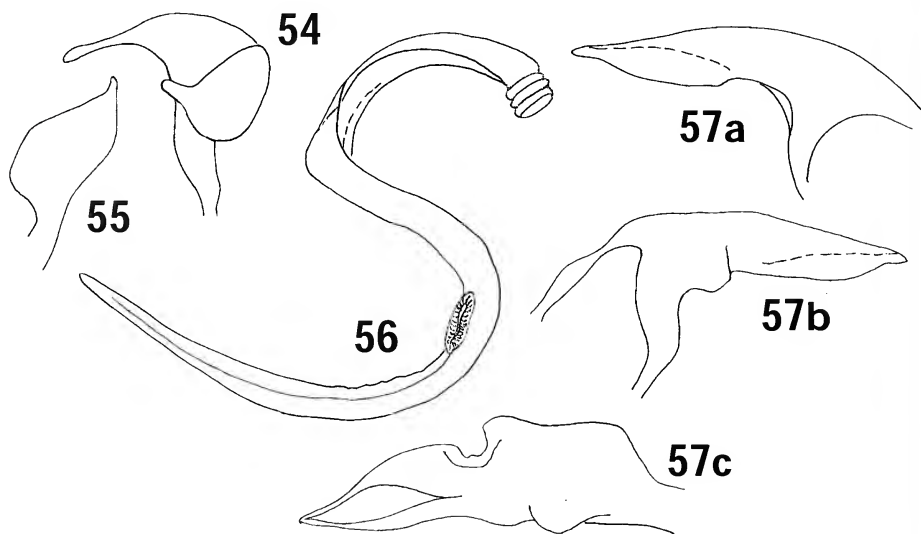
Usinger (CAS); 1 ♂, Graham Co., Stockton Pass, Pinaleno Mts., elev. 5,200–5,500 ft, June 1–2, 1983, R. T. Schuh and G. M. Stonedahl colls., collecting at night on white sheet attracted by mercury vapor trap (AMNH); 14 ♂♂, 12 ♀♀, Mohave Co., Hualapi Mts., SE Kingman, T20W R15W, 4,000–6,400 ft, June 9–10, 1983, R. T. Schuh, M. D. Schwartz, and G. M. Stonedahl, taken on *Quercus gambelii* Nutt. (Fagaceae) (AMNH; 4 USNM). **Colorado:** 5 ♀♀, Douglas Co., Perry Park, VII-8-82, J. T. Polhemus, on *Quercus gambelii* (Gambel oak) (JTPC); 3 ♂♂, 4 ♀♀, Garfield Co., 10 mi E. Glenwood Springs, VI-22-82, J. T. Polhemus, on *Quercus gambelii* (Gambel oak) (JTPC); 2 ♀♀, Garfield Co., W Evacuation Creek, 11 mi SE CO St. Border, on UT Rt. 45, el. 6,800 ft, July 9, 1981, M. D. Schwartz, taken on *Quercus gambelii* Nutt. (Fagaceae) (AMNH); 3 ♂♂, Grand Co., nr. Taylor Flats, VII-4-80, J. T. and D. A. Polhemus (JTPC); 5 ♀♀, Jefferson Co., Deer Creek Cyn., VII-27-82, J. T. Polhemus, on *Quercus gambelii* (Gambel oak) (JTPC); 1 ♀, Montrose Co., 18 mi E. of Naturita on Colo. 90, VII-7-80, J. T. and D. A. Polhemus (JTPC). **New Mexico:** 8 ♂♂, same data as for holotype (JTPC, NMNH). **Utah:** 3 ♂♂, 15 ♀♀, Carbon Co., entr. Price Cyn Recr. Area, 8 mi NW Helper, rt. 50/6, T12E R9E, 8,000 ft, July 9, 1982, M. D. Schwartz, on *Quercus gambelii* Nutt (AMNH); 32 ♂♂, 10 ♀♀, Garfield Co., Mt. Hillers at Starr Springs Cmpgrnd, T34S, R11E, 6,300 ft, June 18, 1983, R. T. Schuh and M. D. Schwartz colls., at mercury vapor light (AMNH; 6 USNM); 1 ♀, Salt Lake Co., mouth of Little Cottonwood Can., on UT St. Rt. 210, elev. 5,800 ft, June 28, 1981, M. D. Schwartz, on *Quercus gambelii* Nutt. (AMNH); 1 ♀, Sanpete Co., Cottonwood Creek, 4.7 mi NE Fairview on 31, 0.5 mi. W Nat'l For. Rd, 7,000 ft, July 12, 1981, M. D. Schwartz, on *Quercus gambelii* Nutt. (AMNH); 2 ♀♀, Sevier Co., Clear Creek Narrows Summit on Rt. 4, 2,244 m, July 15, 1980, R. T. Schuh and G. M. Stonedahl, on *Quercus* sp. (AMNH); 4 ♀♀, Sevier Co., 1.3 mi E Hwy 25 on Mytoge Mtn. Rt., VII-16-1980, 8,600 ft, M. D. Schwartz, labeled as on *Artemisia* sp. (AMNH); 3 ♂♂ (one nymph), Utah Co., Provo Canyon, rt. 92, 1 mi W Sundance Ski Resort, el. 8,000 ft, T4S R3E, July 4, 1982, M. D. Schwartz, on *Quercus gambelii* Nutt (Fagaceae); 1 ♀, Wasatch Co. Dock Flat, 1 mi NE of Ut St. rt. 40, T2S W12W, Sec. 9, elev. 8,000 ft, Aug. 14, 1982, M. D. Schwartz, on *Quercus gambelii* Nutt (AMNH); 7 ♀♀, Wasatch Co., 5 mi W Duchesne Co. line on Ut St. rt. 40, Deep Cyn. T3S R9W, 7,000 ft, July 5, 1981, M. D. Schwartz, on *Quercus gambelii* Nutt (AMNH); 5 ♀♀, Vivian Park, VII-7-22, E. P. Van Duzee (CAS).

Genus *Icodema* Reuter, 1875

Icodema Reuter 1875: 97. Type species: *Plagiognathus infuscatus* Fieber 1861. Monotypic.

Diagnosis. This genus is recognized in the Palearctic by the keeled male genital capsule, the lack of dark spots at the bases of the tibial spines, and the pallid to pale greenish white overall coloration, with only the first antennal segment infuscated and, according to Wagner (1975), with the membrane dark spotted. Autapomorphic for the genus are the very slender S-shaped vesica, with the secondary gonopore well back from the apex, and laterally notched phallosome.

Description. Length 3.70 to 4.70 mm. Elongate, oval. Overall coloration pale yellow. Head broader than long, slightly wider at base than anterior margin of pronotum;



Figs. 54–57. Male genitalia of *Icodema infuscatum*. 54. Left paramere. 55. Right paramere. 56. Vesica. 57a. Phallosome, right lateral aspect. 57b. Phallosome, left lateral aspect. 57c. Phallosome, dorsal aspect.

eyes prominent, granulate, larger in males; vertex relatively narrow, less than $\frac{1}{2}$ the width of head in males, nearly half the width of head in females. Rostrum extending to apices of metacoxae; segment IV longest, length of segments I–III subequal. Antennae long, slender, ranging from 0.72–0.74 the length of body in $\delta\delta$, from 0.71–0.75 in $\eta\eta$; segment I shortest, thickest; segment IV next shortest, slightly more than two times length of I; segment II longest, about two times length of segment III. Pronotum trapeziform, basal width about two times median length; calli weakly defined; scutellum equilateral. Hemelytra subparallel, opaque to nearly translucent on corium; membrane translucent, with two distinct areoles; pubescence relatively short, simple, and recumbent. Legs slender, unmarked, tibial spines lacking dark spots at bases. Male genital capsule with a distinct, ventral, median keel extending from base of segment to ventral edge of aperture; left (Fig. 54) paramere; right (Fig. 55) paramere; vesica S-shaped (Fig. 56), very slender, secondary gonopore small, well back from apex to nearly middle of structure; phallosome (Figs. 57a, b, c) with a distinct notch on right side, most visible from dorsal aspect.

Icodema infuscatum (Fieber), 1861

Figs. 54–57

Plagiognathus infuscatus Fieber 1861: 303.

Icodema infuscatum: Reuter 1875: 97; Oshanin 1909: 896; Wagner 1975: 291; Ehan-
no 1987a: 385, 1987b: 1036.

Icodema infuscatum notaticornis Rey 1894: 1.

Orthotylus pallidus Meyer-Dür 1870: 209. Synonymized by Puton 1873: 24; fol-
lowed by Reuter 1875: 97.

Icodema infuscata annulata Stichel 1956: 276.

Icodema infuscata: Schuh 1995: 326.

Diagnosis. Uniformly pallid to pale green, with antennal segment I often infuscated, legs unmarked, genital capsule distinctly keeled, phallosome notched, forming a toothlike process laterally, and vesica very slender and S-shaped.

Description. Male (N = 5): Length 3.72–4.28 mm, width 1.24–1.44 mm. Overall coloration pallid to pale yellow. *Head*: Width 0.76–0.78 mm, vertex 0.30–0.32 mm; uniformly pale yellow, with apex of tylus usually infuscated. *Rostrum*: Length 1.40–1.60 mm, extending to metacoxae. *Antenna*: Segment I, length 0.26–0.28 mm; II, 1.36–1.50 mm; III, 0.72–0.82 mm; IV, 0.44–0.48 mm; uniformly pale yellow, with segment I often becoming brown; segment II becoming brown in variety *notaticorne* (Wagner 1975). *Pronotum*: Length 0.50–0.58 mm, basal width 1.00–1.12 mm; pale yellow. Hemelytra pale yellow; membrane uniformly translucent pale yellow but, according to Wagner (1975), dark spotted [however, none of the specimens examined have a spotted membrane]; pubescence short, simple, pale yellow, and recumbent. Legs uniformly pale yellow, lacking spots at bases of tibial spines.

Male genital capsule with a distinct ventral median keel; left paramere (Fig. 54); right paramere (Fig. 55); vesica (Fig. 56) very slender, S-shaped, with secondary gonopore well back from apex; phallosome (Figs. 57a, b, c), with a deep notch and tooth subbasally.

Female (N = 4): Length 4.08–4.56 mm, width 1.56–1.68 mm. *Head*: Width 0.76–0.78 mm, vertex 0.34–0.36 mm. *Rostrum*: Length 1.70–1.74 mm, extending to metacoxae. *Antenna*: Segment I, length 0.28–0.32 mm; II, 1.50–1.58 mm; III, 0.84–0.90 mm; IV, 0.42–0.46 mm. *Pronotum*: Length 0.56–0.60 mm; basal width 1.12–1.22 mm.

Females are similar to males, but with broader bodies, narrower heads with smaller, less granulate eyes and a broader vertex.

Hosts. Adults reported on oak, *Quercus* sp., during May and June (Wagner 1975); adults May to July on *Q. pubescens* in France (Ehanno 1987a).

Distribution. Austria, Bulgaria, Finland, France, Germany, Greece, Italy, Spain, Switzerland, Turkey, Yugoslavia; Mediterranean Region, Asia Minor, Balkan Peninsula (Carvalho 1958, Wagner 1975, Ehanno 1987b, Schuh 1995).

Material examined. AUSTRIA: 1 ♂, 1 ♀, Bisamberg, Austr. Inf. (BNHM). GERMANY [?]: 2 ♂♂, 2 ♀♀, Görz, Carniolia (BNHM). SPAIN: 1 ♂, 1 ♀, Seva (Barcelona), 2 April 1956, Ribes, on *Quercus* sp. (USNM); 1 ♂, Benicassim (Castellón), 2 April 1956, Ribes (USNM).

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and A. G. Wheeler, Jr. (Department of Entomology, Clemson University, Clemson, South Carolina) kindly reviewed the manuscript.

LITERATURE CITED

- Blatchley, W. S. 1926. Heteroptera or True Bugs of Eastern North America, with Especial Reference to the Faunas of Indiana and Florida. Nature Publishing Company, Indianapolis, 1116 pp.
- Carvalho, J. C. M. 1955. *Analecta miridologica*: miscellaneous observations in some American museums and bibliography (Hemiptera). *Revista de Chilena Entomologia* 4:221-227.
- Carvalho, J. C. M. 1958. Catalogue of the Miridae of the world. Part II. Phylinae. *Arquivos do Museu Nacional, Rio de Janeiro* 45(2):1-216.
- Ehanno, B. 1987a. Les Heteropteres Mirides de France. Tome II-A: inventaire et syntheses ecologiques. *Inventaires Faune Flore, Museum National D'Histoire Naturelle, Paris*. 40: i-x + 97-647.
- Ehanno, B. 1987b. Les Heteropteres Mirides de France. Tome II-B: inventaire biogeographique et atlas. *Inventaires Faune Flore, Museum National D'Histoire Naturelle, Paris*. 42:i-ix + 649-1075.
- Fieber, F. X. 1860-1861. Die europäischen Hemiptera. Halbflügler (Rhynchota Heteroptera). Nach der analytischen Methode bearbeitet. Gerold, Wien. 1860, i-vi, 1-112; 1861, 113-444, 2 plates.
- Froeschner, R. C. 1949. Contributions to a synopsis of the Hemiptera of Missouri, pt. IV. Hebridae, Mesoveliidae, Cimicidae, Anthocoridae, Cryptostemmatidae, Isometopidae, Miridae. *American Midland Naturalist* 42:123-188.
- Henry, T. J. 1989. *Cariniocoris*, a new phyline plant bug genus from the eastern United States, with a discussion of generic relationships (Heteroptera: Miridae). *Journal of the New York Entomological Society* 97:87-99.
- Henry, T. J. 1991. Revision of *Keltonia* and the cotton fleahopper genus *Pseudatomoscelis*, with the description of a new genus and an analysis of their relationships (Heteroptera: Miridae: Phylinae). *Journal of the New York Entomological Society* 99:351-404.
- Henry, T. J. and C. L. Smith. 1979. An annotated list of the Miridae of Georgia (Hemiptera-Heteroptera). *Journal of the Georgia Entomological Society* 14:212-220.
- Henry, T. J. and A. G. Wheeler, Jr. 1988. Family Miridae Hahn, 1833 (= Capsidae Burmeister, 1835). The plant bugs. pp. 251-507 in Henry, T. J. and R. C. Froeschner (eds.), *Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States*. E. J. Brill, Leiden and New York, 958 pp.
- Kelton, L. A. 1980. The plant bugs of the prairie provinces of Canada. Heteroptera: Miridae. The insects and arachnids of Canada. Part 8. Agriculture Canada Research Publication, No. 1703. Ottawa, 408 pp.
- Kelton, L. A. 1982. Description of a new species of *Plagiognathus* Fieber, and additional records of European *Psallus salicellus* in the Nearctic Region (Heteroptera: Miridae). *Canadian Entomologist* 114:169-172.
- Kerzhner, I. M. and R. T. Schuh. 1998. Replacement names for junior homonyms in the family Miridae (Heteroptera). *Zoosystematica Rossica* 7:171-172.
- Khalaf, K. T. 1971. Miridae from Louisiana and Mississippi (Hemiptera). *Florida Entomologist* 54:339-342.
- Knight, H. H. 1923. Family Miridae (Capsidae). pp. 422-658 in Britton, W. E. (ed.), *The Hemiptera or Sucking Insects of Connecticut*. Connecticut Geological and Natural History Survey Bulletin 34:1-807.
- Knight, H. H. 1941. The plant bugs, or Miridae, of Illinois. *Illinois Natural History Survey Bulletin* 22:1-234.

- Knight, H. H. 1953. New species of Miridae from Missouri (Hemiptera). Iowa State College Journal of Science 27:509–518.
- Meyer-Dür, L. R. 1870. Hemipterologisches. Zwei neue grünen *Lygus* Arten. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 3:206–210.
- Oshanin, B. F. 1906–1909. Verzeichnis der Palaearktischen Hemipteren mit besonderer Berücksichtigung ihrer Verteilung im russischen Reiche. Beilage zum, Annuaire Musée Zoologique de l'Académie Impériale des Sciences. St. Petersburg, Vol. I. Part I:1–393 (1906); part II: 395–586 (1908); part III: 587–1087 (1909).
- Polhemus, D. A. 1994. An annotated checklist of the plant bugs of Colorado (Heteroptera: Miridae). Pan-Pacific Entomologist 70:122–147.
- Puton, A. 1873. Notes pour servir à l'étude des Hémiptères. 2ème Partie. Annales de la Société Entomologique de France (5):4:213–234.
- Reuter, O. M. 1875. Revisio critica Capsinarum, praecipue Scandinaviae et Fenniae. Akademisk Afhandling, Helsingfors 1(1):1–101; 1(2):1–190.
- Rey, C. 1894. Remarques en passant. Exchange 10:1.
- Schuh, R. T. 1995. Plant Bugs of the World (Insecta: Heteroptera: Miridae). Systematic Catalog, Distributions, Hosts List, and Bibliography. The New York Entomological Society, New York, 1329 pp.
- Steyskal, G. C. 1973. The grammar of names in the catalogue of the Miridae (Heteroptera) of the world by Carvalho (1957–1960). Studia Entomologica 16:203–208.
- Stichel, W. 1934. Illustrierte Bestimmungstabellen der Deutschen Wanzen. Fasc. 10. W. Stichel, Berlin-Hermsdorf. Pages 459–499.
- Stichel, W. 1956. Illustrierte Bestimmungstabellen der Deutschen Wanzen. II. Europa (Hemiptera-Heteroptera Europae). Fasc. 2–15. W. Stichel, Berlin-Hermsdorf. Pages 170–480.
- Wagner, E. 1975. Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera). Entomologische Abhandlungen 40(Suppl.):1–483.
- Wheeler, A. G., Jr. 1995. *Deraeocoris manitou* and *Plagiognathus albellus* (Heteroptera: Miridae): first eastern U. S. records. Banisteria 6:28–30.
- Wheeler, A. G., Jr. and T. J. Henry. 1977. Rev. Modestus Wirtner: Biographical sketch and additions and corrections to the Miridae in his 1904 list of western Pennsylvania Hemiptera. Great Lakes Entomologist 10:145–157.
- Wirtner, M. 1904. A preliminary list of the Hemiptera of western Pennsylvania. Annals of the Carnegie Museum 3:183–232.

NEW GENERA AND SPECIES OF CONIFER-INHABITING PHYLINE PLANT BUGS FROM NORTH AMERICA (HETEROPTERA: MIRIDAE)

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Abstract.—Three new genera of phyline Miridae are described from North America to accommodate two taxa removed from *Plagiognathus* and five newly recognized species from the western part of the continent. *Coniferocoris*, new genus comprises the type species *C. pinicolus* and two additional new species, *C. abiesicolus*, and *C. polhemi*; *Piceophylus*, new genus comprises the type species *P. keltoni*, new species; and *Pinophylus*, new genus comprises the type species *Plagiognathus rolfsi* Knight, *Plagiognathus carneolus* Knight, and the new species *Pinophylus stonedahli*. Two new species are placed in *Psallivius* Henry: *P. nigroantennatus* and *P. dimorphicus*, and new distributional and host records for *P. flaviclavus* (Knight) are given. The male genitalic structures of all species are illustrated, and scanning electron micrographs are presented for the head, dorsal vestiture, and pretarsus of representative species. Habitus views as photographs or illustrations are provided for all species.

The conifer-feeding Miridae have been the subject of a number of revisionary works, as for example the mirine genera *Platylygus* (Kelton and Knight, 1970), *Pinalitus* (Kelton, 1977), and *Dichroscytus* (Kelton, 1972). Stonedahl and Schwartz (1996) described two new genera of conifer-feeding Phylinae and Stonedahl (1990) revised *Atractotomus*, some of whose members are conifer feeders. Nonetheless, the taxonomy of conifer-feeding Phylinae in general remains inadequately studied and several species remain undescribed. In the present paper we recognize additional monophyletic groups of conifer-feeding North American Phylinae and document the species diversity, host associations, and distributions of those groups.

The species included in this paper have come to light in part through the ongoing work of the junior author on *Plagiognathus* Fieber and the recently published work of Stonedahl (1990) on *Atractotomus* Fieber. Although in the final analysis we were able to assemble a reasonable sample of specimens, this was made possible only through the sorting of large amounts of material from existing collections and through our own extensive field work in the western United States. None of the taxa described here are common in collections, and in particular, the small, somber-colored species of *Coniferocoris* are inconspicuous when mixed in with large numbers of similarly sized and colored specimens of *Plagiognathus*.

The three new genera described below share certain attributes that may suggest a close relationship among them. First is the conspicuous sexual dimorphism, most

particularly in antennal segment 2, which in the male is cylindrical and of conspicuously larger diameter than in the female. Similar dimorphism is found in all species of *Campylomma* Reuter and *Rhinacloa* Reuter and in some species of *Atractotomus*, among other genera, but on the basis of other attributes, these groups seem to share little in common with the conifer feeders described in this paper.

Second, and possibly more important, is the form of the head, wherein the males in particular have the posterior margin of the eyes weakly to conspicuously removed from the anterior margin of the pronotum and distinctly transverse in appearance. In the females of some species the eyes are not so strongly removed from the pronotum as in the males, and the head is more strongly produced anteriorly, with the consequent loss of the transverse aspect found in the males.

In spite of these and other similarities, the male genitalia show substantial variation and on that basis we have chosen to assign the species to three distinct genera.

We dedicate this work to our long-time friend and colleague John T. Polhemus, in recognition of his substantial contributions to our knowledge of the Heteroptera. John has devoted much of his life to the study of Heteroptera, particularly the aquatic and semiaquatic families. His tireless efforts in the field have produced, in addition to aquatic bugs, large numbers of specimens of Miridae, some of them belonging to the taxa discussed herein. It is with great pleasure that we name one of the new species in John's honor.

All measurements are given in millimeters. When available, five specimens of each sex were measured with the mean and range reported for each species. The authors of the host plants recorded follow the nomenclature of Fernald (1950) or Munz and Keck (1970).

Coniferocoris, new genus

Figs. 1–6

Type species. *Coniferocoris pinicolus* Schwartz and Schuh, new species.

Diagnosis. Recognized among other Phylini by the following suite of characters: small body, coloration ranging from tan to nearly black, sometimes with pale markings; evenly distributed, moderate length, reclining, black or brown simple setae on dorsum; prominent or short anteocular portion of head; antennal segment 2 cylindrical and of greater diameter in males than females; labium reaching from apex of hind coxa to middle of the abdominal sternum; pretarsus with claw relatively broad basally, slender distally, pulvillus small, parempodia setiform and short (Figs. 5D, 6E); vesica J-shaped, with two, very short apical spines (Fig. 2A, B, F), secondary gonopore only slightly removed from apex and moderately large; and left paramere with relatively long, narrow anterior lobe (Fig. 2C).

Coniferocoris can be distinguished from other small, conifer-inhabiting western Phylini by the presence of simple, short, dark, dorsal setae (Figs. 5C, 6D). The dorsal vestiture of *Atractotomus*, *Knightomiroides* Stonedal and Schwartz, *Phoenicocoris* Reuter, and *Pinomiris* Stonedahl and Schwartz species includes either silvery white, silky setae or white, flattened scale-like setae; small, conifer-feeding *Plagiognathus* species have obviously longer and more densely distributed dorsal setae than *Conifericoris* spp. The structure of the vesica will separate *Conifericoris* from other



Fig. 1. Dorsal habitus photograph of *Coniferocoris abiesiculus* Schwartz and Schuh, female.

phyline genera, and the sexually dimorphic second antennal segment will easily distinguish its species from the males of *Plagiognathus*.

Description. Male. *Head*: frons strongly declivent or gently sloping (Figs. 5A, 6A); clypeus either strongly produced or small, barely visible in dorsal view (Fig. 3C); sometimes frons with faint transverse striations; posterior margin straight; vertex slightly convex, basal carina obsolete; mandibular and maxillary plates not produced, maxillary plate slightly sunken, gena and gula small; buccal cavity large, ovoid; eyes large, subequal to head height in lateral view, dorsal margin produced dorsal to vertex, posterolateral margin slightly but distinctly removed from anterolateral margin of pronotum, emarginate anteriorly; antennal insertion subcontiguous or contiguous with anterior margin of eye, slightly dorsal to ventral margin of eye; antennal segment 1 not thickened, short, segment 2 linear, thickened, of uniform diameter (Fig. 4), length greater than width of head across eyes; segments 3 and 4 of much smaller diameter than segments 1 and 2; reaching from apex of hind coxa to abdominal sternum 6. *Thorax*: pronotum trapeziform, as wide as long, lateral margins nearly straight, posterior margin slightly concave; disk flattened, without distinct anterior and posterior lobes; calli slightly convex, sometimes subconfluent medially; mesoscutum broadly exposed; scutellum slightly convex; thoracic pleura subglabrous; metathoracic scent-gland evaporatory area as in Fig. 6C. *Hemelytra*: moderately elongate, subparallel-sided; cuneus shorter than width of head across eyes, longer, than broad, slightly deflexed, apex just exceeding apex of genital segment, in lateral

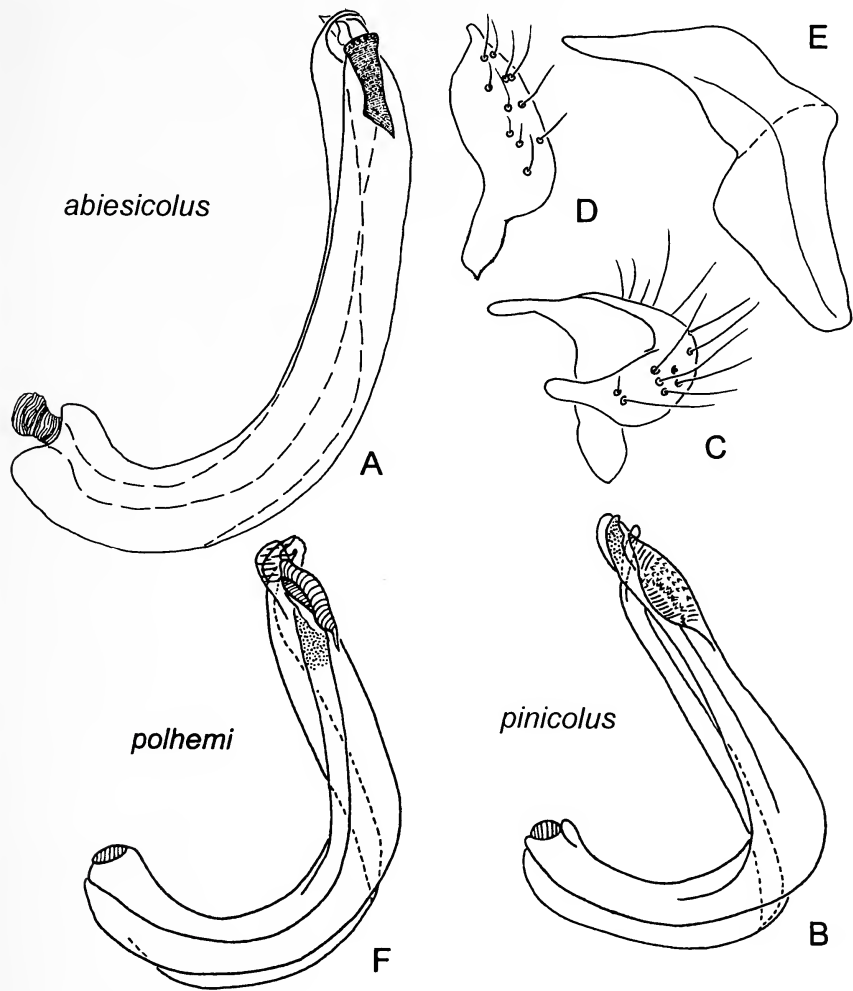


Fig. 2. Male genitalia of *Coniferocoris* spp. A. *C. abiesiculus* Schwartz and Schuh, vesica. B–E. *C. pinicolus* Schwartz and Schuh. B. Vesica. C. Left paramere. D. Right paramere. E. Phallosome. F. *C. polhemi* Schwartz and Schuh, vesica.

view. *Venter*: evenly covered with reclining simple setae. *Legs*: tibiae without dark spots at bases of tibial spines; tibial spines either black or pale brown. *Male genitalia*: Genital capsule: conical, apex gently rounded; ventral medial surface of genital segment with many short simple setae, without carina or keel. Left paramere (Fig. 2C): small, anterior lobe long, length subequal to posterior lobe, posterior lobe gently attenuate and slightly recurved. Right paramere (Fig. 2D): subovoid attenuate apically. Phallosome (Fig. 2E): relatively short, with slot-like aperture. Vesica (Figs. 2A, B, F): J-shaped, of roughly equal thickness throughout; vesical straps terminating

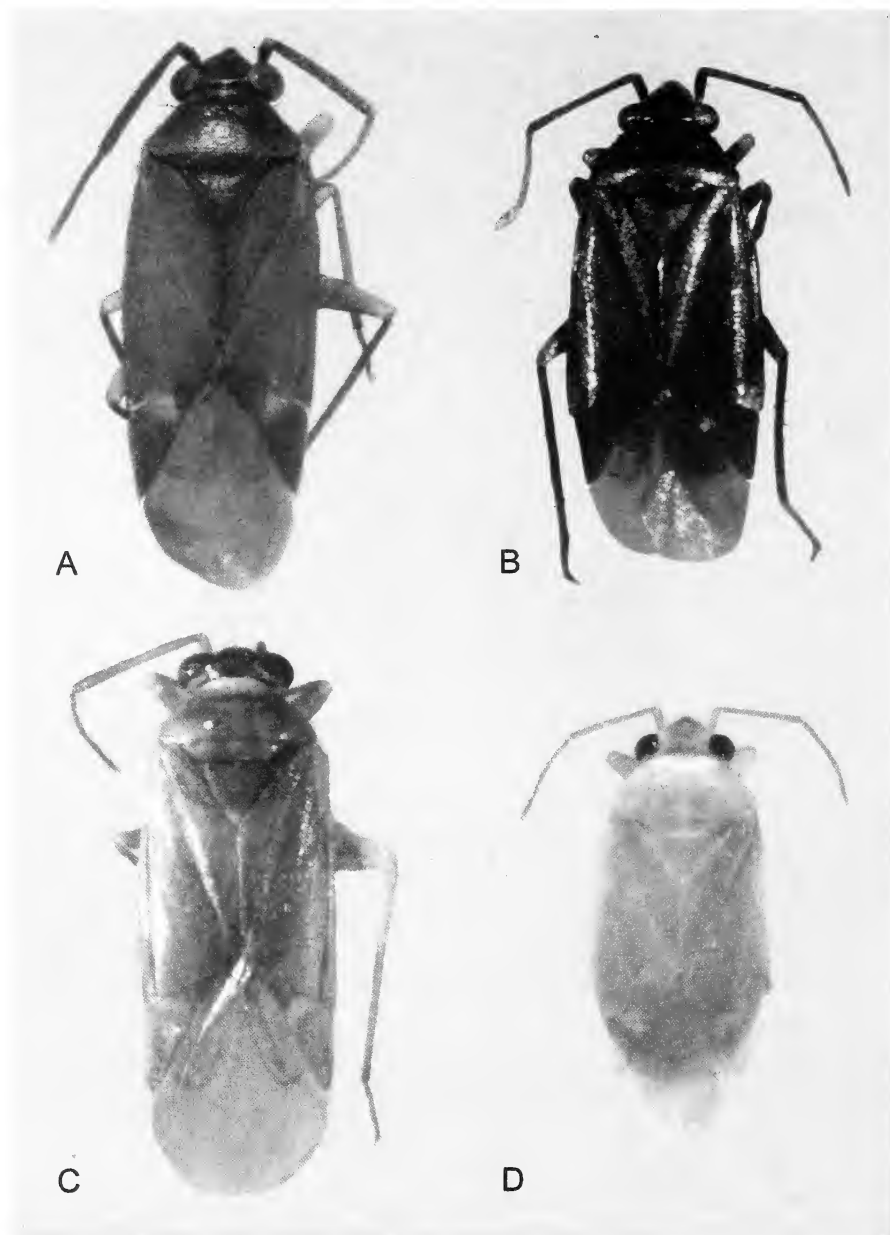


Fig. 3. Dorsal habitus photographs of *Coniferocoris* spp. A, B. *C. pinicolus* Schwartz and Schuh. A. Male. B. Female. C, D. *C. polhemi* Schwartz and Schuh. C. Male. D. Female.

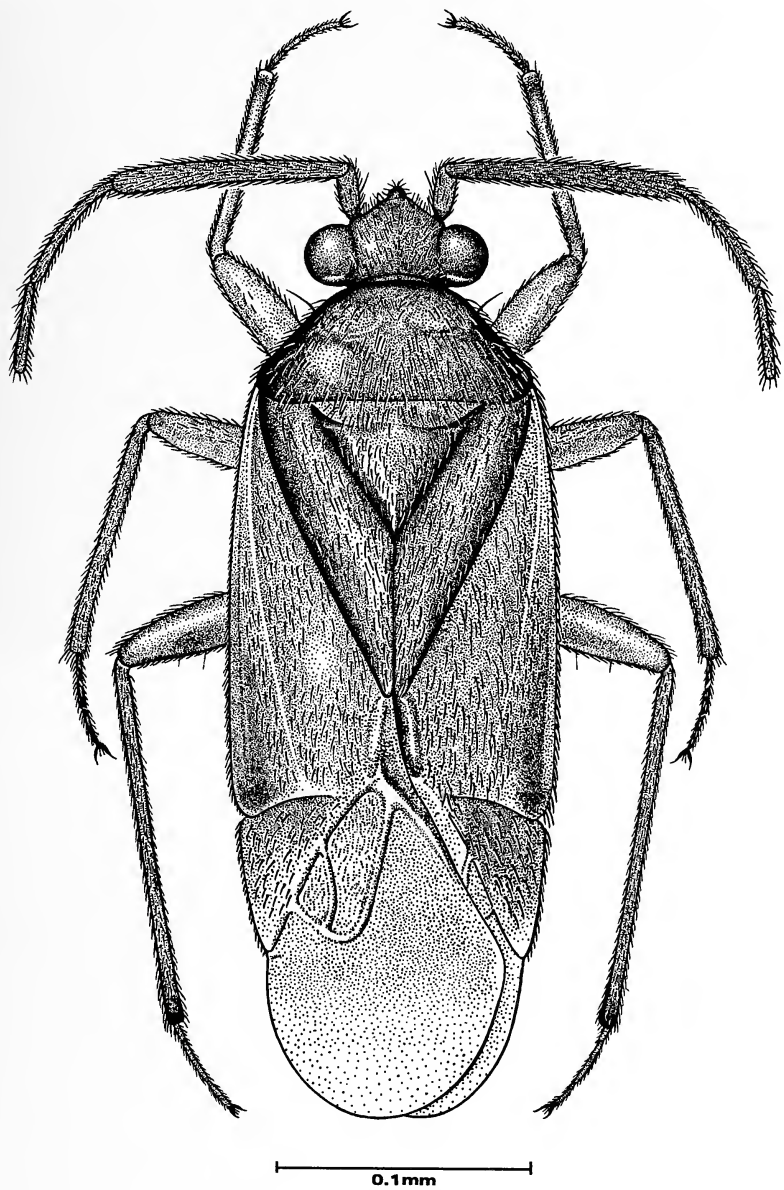


Fig. 4. Dorsal habitus illustration of *Coniferoecoris pinicolus* Schwartz and Schuh.

with pointed or slightly recurved apices; well-sclerotized secondary gonopore situated subapically.

Female (Figs. 3B, D, 5B, 6B). Similar to male except body much more strongly

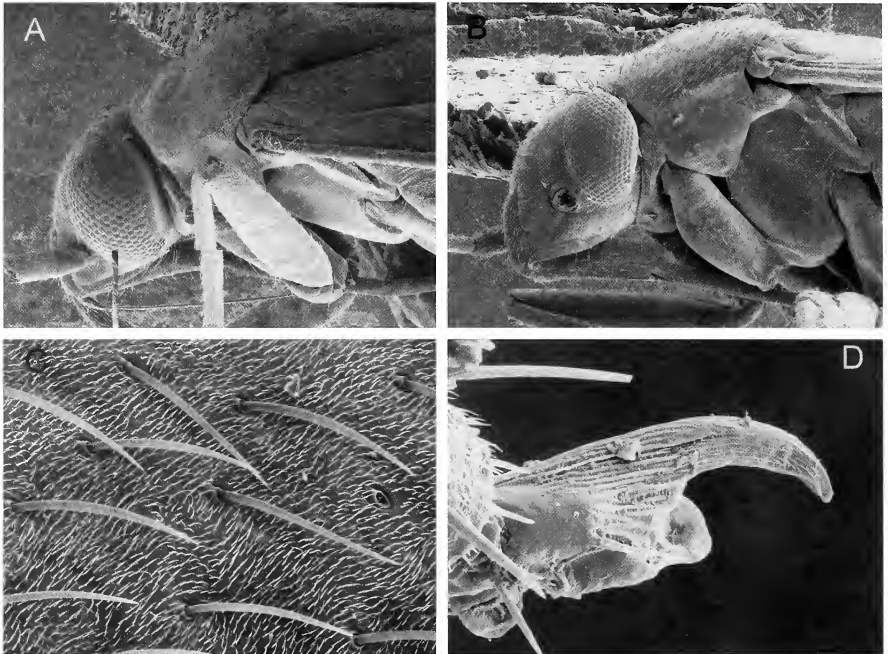


Fig. 5. Photomicrographs of *Coniferocoris pinicolus* Schwartz and Schuh. A. Head and propleuron, lateral view, male. B. Head and propleuron, lateral view, female. C. Dorsal setae. D. Pretarsus, lateral view.

ovoid, eyes smaller, antecular portion of head more strongly produced, vertex wider, and antennal segment 2 much more slender than in male.

Etymology. Named for the apparent strict association of the all known species with coniferous trees; masculine.

Discussion. Three species occur in western cordilleran North America and breed on conifers.

KEY TO SPECIES OF *CONIFEROCORIS*

- 1. Pronotum pale yellowish orange to pale brown *polhemi* n.sp.
- Pronotum castaneous, dark brown, or black 2
- 2. Pronotum castaneous and hemelytra reddish brown; antennae pale *abiesicolus* n.sp.
- Pronotum and hemelytra concolorous dark brown to black, with only base of cuneus faintly pale; antennae dark *pinicolus* n.sp.

***Coniferocoris abiesicolus*, new species**

Figs. 1, 2A

Diagnosis. Recognized by the deeply castaneous head (Fig. 1), labial segment 1, thorax, mesoscutum, scutellum, bases of coxae, and venter, reddish brown hemelytra, and pale yellow antennal segments 1 and 2 and legs; vestiture of golden simple setae, labium just surpassing hind coxa; and large vesica. Distinguished from *C.*

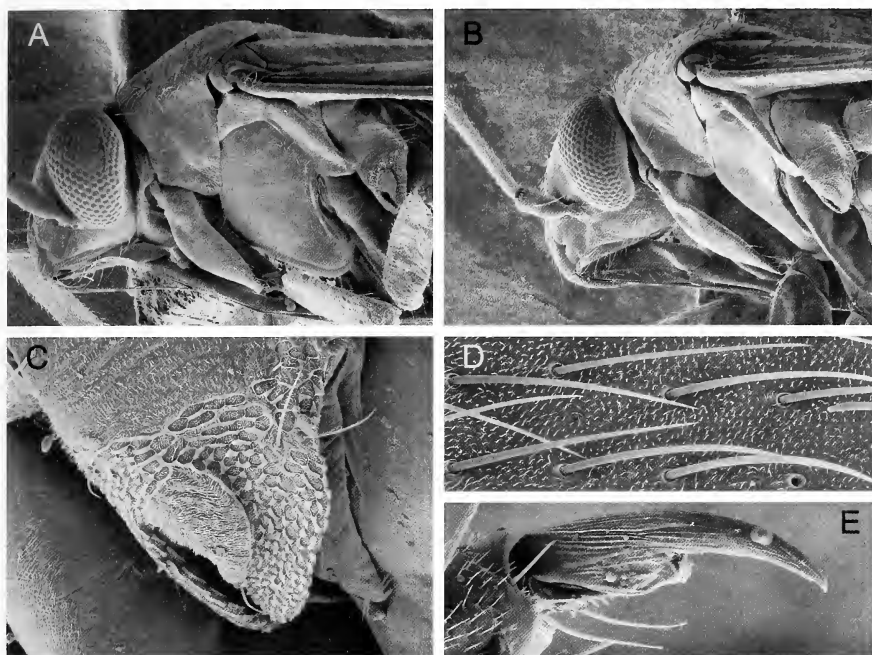


Fig. 6. Photomicrographs of *Coniferocoris polhemi* Schwartz and Schuh. A. Head and propleuron, lateral view, male. B. Head and propleuron, lateral view, female. C. Ostiolar peritreme. D. Dorsal setae. E. Pretarsus, lateral view.

pinicolus by the pale antennae and from *C. polhemi* by the red to castaneous coloration of the dorsum. The dorsal vestiture of *C. abiesicolus* is also slightly longer and less neatly arranged than in its congeners.

Description. Male. Total length 3.2 (3.1–3.3); head and thorax shining black, hemelytra reddish brown, antennae and legs pale yellow; dorsum with evenly distributed, moderate length, recurved, fine, golden, simple setae. *Head*: anteocular portion moderately short; castaneous; width 0.74 (0.73–0.74); vertex width 0.30; eyes large; antennae pale yellow; antennal segments 3 and 4 sometimes slightly darkened; antennal measurements 0.21: 0.84 (0.80–0.88): 0.46 (0.43–0.48): 0.33; labium exceeding apex of hind coxa, length 1.44 (1.43–1.45), yellow, segments 1 and 4 darkened. *Thorax*: propleura, mesoscutum, scutellum, and peritremal disk castaneous; sometimes calli black. *Hemelytra*: reddish brown, base of cuneus hyaline; membrane pale, veins infuscate. *Venter*: castaneous. *Legs*: pale yellow; bases of middle and hind coxae castaneous; tibial spines dark brown; tarsi sometimes dusky brown. *Genitalia*: see Fig. 2A.

Female. Total length 3.1 (2.9–3.2); head width 0.73 (0.69–0.76); vertex width 0.35 (0.34–0.36); antennal measurements 0.21 (0.20–0.23): 0.73 (0.68–0.79): 0.48 (0.44–0.50): 0.34 (0.33–0.34); labium reaching base of ovipositor, length 1.48 (1.43–1.55).

Etymology. Named for the host genus.

Hosts. Taken on white fir, *Abies concolor* (Gord. & Glend.) Lindl. and subalpine fir, *A. lasiocarpa* (Hook.) Nutt.

Distribution. Known from Wheeler Peak, Nevada, and Vail, Colorado.

Discussion. This species is known from only a limited number of specimens from disjunct localities in eastern Nevada and central Colorado. It will probably prove to be more widely distributed in the central Rockies, but such knowledge will only become available with additional collecting on *Abies* spp. at mid to high altitudes. *Coniferocoris abiesicolus* appears to breed exclusively on *Abies* spp., whereas *C. pinicolus* and *C. polhemi* seem to be restricted to *Pinus* spp. This is the most colorful of the *Coniferocoris* spp.

Holotype. ♂, "USA, Nevada, White Pine Co., Wheeler Peak Rd. W of Baker, Humboldt Nat. For.; 2,609 m, July 14, 1980, R.T. Schuh, G.M. Stonedahl; ex *Abies lasiocarpa* (Pinaceae)." Deposited in the American Museum of Natural History, New York.

Paratypes. USA, Nevada: White Pine Co., Wheeler Peak Drive, elev. 7,000–10,000 ft, 6.viii.1982, M.D. Schwartz, ex *Abies concolor*, 1 ♂, 4 ♀ (AMNH and CNC). Additional specimens: USA, Colorado: Eagle Co., Vail, 20.vi.1982, J.T. Polhemus, ex *Abies* sp., 2 ♀ (JTPC).

***Coniferocoris pinicolus*, new species**

Figs. 2B–E, 3A, B, 4, 5

Diagnosis. Recognized by the uniformly brown to black dorsum, antennae, legs, tibial spines, and labium; vestiture of black simple setae; and labium long, reaching middle of abdomen. Easily distinguished from *C. abiesicolus* and *C. polhemi* by the dark antennae and tibiae.

Description. Male (Figs. 3A, 4). Total length 3.2 (3.0–3.3); weakly shining, uniformly brown to black with base of cuneus faintly pale; dorsum with evenly distributed, moderate length, reclining, fine, black simple setae. **Head:** anteocular portion long (Fig. 5A); reddish brown to black, including vertex; mandibular plate sometimes castaneous; width 0.68 (0.66–0.71); vertex width 0.31 (0.29–0.32); antennae brown to black; antennal measurements 0.21 (0.20–0.23): 0.83 (0.71–0.93): 0.46 (0.43–0.50): 0.46 (0.44–0.50); labium brown to black, reaching from sternite 4 to 6, length 1.54 (1.50–1.60). **Thorax:** propleura, mesoscutum, scutellum, and peritremal disk reddish brown to black. **Hemelytra:** membrane and veins infusate. **Venter:** brown to black. **Legs:** brownish black; femora sometimes pale yellow; apices of coxae slightly pale, tibial spines black. **Genitalia:** see Figs. 2B–E.

Female (Fig. 3B). Total length 3.0 (2.8–3.2); head width 0.67 (0.63–0.71); vertex width 0.35 (0.33–0.37); antennal measurements 0.19 (0.18–0.21): 0.73 (0.66–0.83): 0.43 (0.43–0.48): 0.35 (0.34–0.36); labium reaching abdominal sternum 7, length 1.69 (1.55–1.79).

Etymology. Named for the host genus.

Discussion. The secondary gonopore of *C. pinicolus* is longer in the longitudinal plane of the vesica than that of *C. polhemi*. Specimens of *C. pinicolus* collected on *Pinus sabiniana* in central California differ from specimens collected on *P. contorta* in the more northern part of the range by having the distance between the blunt apex and the closest recurved apex of the vesica longer and the color of the femora paler.

Hosts. Taken commonly on lodgepole pine, *P. contorta* Dougl. ex Loud. (and var.

murrayana (Grev. & Balf.) Engelm.), but also known from digger pine, *P. sabiniana* Dougl., and much less commonly yellow pine, *P. ponderosa* Dougl. ex P. & C. Lawson.

Distribution. Southern Okanagan Valley of British Columbia south through coastal Washington and Oregon to the southern Sierra Nevada Mountains of California.

Holotype. ♂, "USA, Washington, Pacific Co., Nahcotta June 14, 1979 R.T. Schuh ex *Pinus contorta*." Deposited in the American Museum of Natural History, New York.

Paratypes. CANADA, **British Columbia:** Rock Crk, 7.vi.1959, L.A. Kelton, 1 ♀ (CNC). USA, **California:** *Contra Costa Co.:* Mt Diablo, 22.iv.1933, R.L. Usinger, 1 ♀ (UCB). Russelman Park: 20.iv.1931, R.L. Usinger, 4 ♀ (UCB); 6.v.1957, H. Ruckes, ex *P. sabiniana*, 1 ♀ (UCB); 18.iii.1959, J. Powell, ex *P. sabiniana*, 3 ♀ (UCB). *Del Norte Co.,* Crescent City, 25.vi.1968, R.P. Allen, 1 ♀ (CAFA). *Fresno Co.,* Huntington Lake, 4.vii.1919, F.E. Blaisdell, 1 ♀ (CAS). *Humboldt Co.:* Samoa: 6.vi.1937, B.P. Bliven, 1 ♂, 4 ♀ (CAS); 31.v.1937, B.P. Bliven, 4 ♂, 5 ♀ (CAS). *Lake Co.,* Middletown, 14.iv.1964, C.W. O'Brien, ex *P. sabiniana*, 1 ♀ (UCB). *Madera Co.,* Beasore Meadows, 23.vii.1946, R.L. Usinger, ex *P. murrayana*, 1 ♀ (UCB). *Mariposa Co.,* Yosemite Nat. Park, Yosemite Crk Ranger Station, 21.vii.1946, R.L. Usinger, ex *P. murrayana*, 3 ♀ (UCB). *Monterey Co.,* Carmel, 21.iii.1940, R.L. Usinger, 1 ♂, 6 ♀ (UCB). *Plumas Co.,* Chester, 18.vi.1959, L.A. Kelton and R. Madge, ex *P. contorta*, 45 ♂, 21 ♀ (CNC). *San Luis Obispo Co.,* Cambria, 2.iv.1960, Gertsch and Schrammel, 1 ♀ (AMNH). *Tehama Co.,* 12 mi E of Mineral on Highway 36, 4,840 ft, 10.vii.1980, G.M. Stonedahl, ex *P. ponderosa*, 2 ♂, 7 ♀ (AMNH); Childs Meadows, 16.vi.1959, L.A. Kelton and R. Madge, 6 ♂, 11 ♀ (CNC); 12 mi E of Mineral on Highway 36, 1,513 m, 10.vii.1980, R.T. Schuh, ex *P. contorta*, 1 ♂, 1 ♀ (AMNH). *Tulare Co.:* 5.7 mi N of Kernville, Hospital Flat Cmpgrd, 28.vi.1978, J.D. Pinto, ex *P. sabiniana*, 5 ♂, 1 ♀ (UCR); Hospital Flat Cmpgrd, 5.7 mi N of Kernville, 28.iv.1978, J.D. Pinto, ex *P. sabiniana*, 1 ♂ (UCR). **Nevada:** *White Pine Co.,* Wheeler Peak Rd, W of Baker, Humboldt Nat. For., 2,688 m, 14.vii.1980, R.T. Schuh and G.M. Stonedahl, ex *P. flexilis*, 2 ♂ (AMNH). **Oregon:** *Clackamas Co.:* 1 mi S of Government Camp, 25.vii.1966, W. Gagne and J. Haddock, ex *P. contorta*, 3 ♂, 26 ♀ (UCB); Government Camp, 25.vii.1966, W. Gagné, J. Haddock, 1 ♂ (UCB). *Crook Co.,* R19E T13S Sec 3, 22.vi.1979, G. Stonedahl, ex *Senecio* sp., 7 ♀ (AMNH). *Deschutes Co.,* T21S R15E Sec 17, 21.vi.1979, G.M. Cooper, ex *P. contorta*, 1 ♂ (OSU). *Douglas Co.,* S. Windy Cove State Park, 30.v.1979, M.D. Schwartz, ex grasses under *Pinus* sp., 1 ♀ (AMNH). *Klamath Co.:* 19 mi SE of Lapine on Highway 31, 4,750 ft, 6.vi.1979, J.D. Lattin, ex *P. contorta*, 1 ♀ (OSU); Crescent Lake Junction, 25.vi.1979, R.T. Schuh, ex *P. contorta*, 1 ♂ (AMNH); Rt 97 at Crescent Lake Junction, 1,530 m, 25.vi.1979, R.T. Schuh, ex *P. contorta*, 10 ♂, 4 ♀ (AMNH). *Lincoln Co.,* South Beach State Park, 29.vi.1994, M.D. Schwartz, ex *P. contorta*, 12 ♀ (CNC). **Washington:** *Clallam Co.,* Deer Park, 5000 ft, 18.vii.1978, J. Schuh, 1 ♀ (AMNH). *Pacific Co.,* Nahcotta, 14.vi.1979, R.T. Schuh, ex *P. contorta*, 8 ♂, 46 ♀ (AMNH).

***Coniferocoris polhemi*, new species**

Figs. 2F, 3C, D, 6

Microphylellus adustus: Polhemus, 1994:130 (misidentification).

Diagnosis. Recognized by the generally tan to orange brown dorsum with pale yel-

low anterior of calli; brown head, antennal segments 3 and 4, tibial spines, tarsi, and genital segment submesially; vestiture of brown simple setae; labium reaching apex of hind coxa; and vesica with a narrow recurved apex and a relatively short secondary gonopore. Distinguished from *C. pinicolus* by the pale antennae and from *C. abiesicolus* by the tan rather than reddish brown coloration of the dorsum.

Two other pale colored conifer-inhabiting Phylini, *Knightomiroides ponderosae* Stonedahl and Schwartz and *K. nigrovirgatus* (Knight), could be confused with *C. polhemi* on the basis of size and general appearance. However the *Knightomiroides* spp. have the dorsum covered with moderately flattened silvery setae and the clypeus is shining castaneous and strongly contrasting with the surrounding coloration of the face, unlike the nearly unicolorous face and vertex of *C. polhemi*.

Description. Male (Fig. 3C). Total length 3.4 (3.1–3.6); dorsum pale yellowish orange brown with evenly distributed, moderate length, reclining, fine, brown, simple setae. *Head*: anteocular portion short (Fig. 6A); dorsal aspect, clypeus, and labrum brown; width 0.71 (0.68–0.76); vertex width 0.29 (0.28–0.30); antennae yellowish brown, segments 3 and 4 brown; segment 2 uniformly thickened; antennal measurements 0.20 (0.19–0.21): 0.88 (0.82–0.90): 0.50 (0.45–0.53): 0.32 (0.30–0.33); labium pale yellow, reaching apex of hind coxa, length 1.24 (1.20–1.25). *Thorax*: dorsum yellowish orange brown, anterior to calli, basalar plate, and epimeron pale yellow; peritremal disk pale. *Hemelytra*: weakly shining yellowish orange brown; membrane slightly infuscate; veins pale yellow. *Venter*: yellowish brown, genital segment with brown mark mesiolaterally. *Legs*: pale yellowish brown; tarsi brown; tibial spines pale brown. *Genitalia*: see Fig. 2F.

Female (Fig. 3D). Total length 2.8 (2.7–3.0); head width 0.68 (0.66–0.72); vertex width 0.33 (0.32–0.35); antennal measurements 0.18 (0.18–0.19): 0.63 (0.63–0.68): 0.43 (0.40–0.44): 0.30 (0.28–0.33); labium reaching apex of hind coxa, length 1.29 (1.23–1.40).

Etymology. Named to honor the productive career of our friend and colleague Dr. John T. Polhemus, who collected some of the paratypes.

Discussion. Sexual dimorphism is much stronger in *C. polhemi* than in the other two species that we have placed in this genus (cf., Fig. 3C, D). In fact, when not associated with the males, females are very difficult to place to genus.

Hosts. Collected from Mexican pinyon pine, *P. cembroides* Zucc., two-needle pinyon, *P. edulis* Engelm., and one-needle pinyon, *P. monophylla* Torr. & Frém.

Distribution. Within the range of pinyon pine from west central Colorado and west central Utah south to western Texas.

Holotype. ♂, "[USA] Utah, San Juan County, Natural Bridges National Monument, (at campground) 6,500 feet, June 17, 1983, R.T. Schuh, M.D. Schwartz; *Pinus edulis* Engelm. (Pinaceae)." Deposited in the American Museum of Natural History, New York.

Paratypes. USA, **Arizona**: *Cochise Co.*: 4 mi W of Portal, 1,700 m, 10.vi.1980, R.T. Schuh, at light, 1♀ (AMNH); 10 mi W of Portal, 2,000 m, 11.vi.1980, R.T. Schuh, K. and R. Schmidt, 1♂ (AMNH). *Maricopa Co.*, 4 Peaks Rd, mp 11, 24.v.1982, J.T. Polhemus, ex pine, 1♀ (JTPC). *Yavapai Co.*: 1 mi E of Yarnell, 29.iv.1981, D.A. and J.T. Polhemus, 1♀ (JTPC); 5 mi N of Prescott Valley, 2,000 m, 20.vi.1980, R.T. Schuh, ex *P. edulis*, 2♂ (AMNH). **California**: *Inyo Co.*, 30 mi N of Saline Valley Lake, 4.v.1974, J.D. Pinto, 2♂ (UCR). **Colorado**: *Eagle Co.*,

Water Wheel Ranch near Bond, 24.vi.1978, J.T. Polhemus, 8♂, 8♀ (JTPC). *Mesa Co.*, Colorado Nat. Monument, Balance Rock Viewpoint, 6,000 ft, 10.vi.1982, M.D. Schwartz, ex *P. edulis*, 9♂, 9♀ (AMNH). *Pueblo Co.*, 12 mi W of Pueblo on Highway 96, 15.vi.1980, J.T. and D.A. Polhemus, 2♂, 10♀ (JTPC). **Nevada:** *Lander Co.*, Kingston Crk Cyn, Toiyabe Mtns, 6,500–7,500 ft, 28.vi.1983, R.T. Schuh and M.D. Schwartz, ex *P. monophylla*, 2♂ (AMNH). *Lyon Co.*, N boundary Toiyabe Nat. For. on Rt. 32, 1,780 m, 11.vii.1980, R.T. Schuh and G.M. Stonedahl, ex *P. monophylla*, 1♀ (AMNH). **Texas:** *Brewster Co.*: Basin, Chisos Mtns, Big Bend Nat. Park: 6,000 ft, 11.v.1959, J.F. Alpine, ex *P. cembroides*, 2♂, 4♀ (CNC); 5,400–6,000 ft, 4.v.1959, W.E.M. Mason, ex *P. cembroides*, 13♂, 12♀ (CNC). *Pecos Co.*: 36 mi S Fort Stockton, 4,500 ft, 2.v.1982, D.A. and J.T. Polhemus, 23♂, 33♀ (JTPC); Fort Stockton, 36 mi S of, 4,500 ft, 2.v.1982, D.A. and J.T. Polhemus, ex *P. edulis*, 1♀ (JTPC). **Utah:** *Emery Co.*, 6.2 mi W Rt. 24 in Temple Wash (Goblin Valley Rd.), 5,000 ft, 19.vi.1983, R.T. Schuh and M.D. Schwartz, ex *P. edulis*, 1♀ (AMNH). *Garfield Co.*: Capitol Reef Nat. Park, Grand Wash, 5,350–6,640 ft, 21.vi.1983, R.T. Schuh and M.D. Schwartz, ex *P. edulis*, 2♂, 5♀ (AMNH); 14.3 mi S of Rt. 95 on Rt. 276, 5,000 ft, 19.vi.1983, R.T. Schuh and M.D. Schwartz, at light, 1♂ (AMNH). *Grand Co.*, 11 mi SE jct 313 ♀ 163 on 313 to Dead Horse Point, 5,200 ft, 11.vi.1982, M.D. Schwartz, ex *P. edulis*, 13♂ (AMNH). *San Juan Co.*: Grand Flat near Collins Cyn, 1.vi.1982, D.A. and J.T. Polhemus, ex *P. edulis*, 3♂, 12♀ (JTPC); White Cyn at Soldiers Crossing, 4,000 ft, 29.v.1978, D.A. and J.T. Polhemus, 4♂, 1♀ (JTPC); 2.7 mi W of Rt. 95 on Rt. 263, 6,000 ft, 18.vi.1983, R.T. Schuh and M.D. Schwartz, ex *P. edulis*, 5♂, 6♀ (AMNH); Natural Bridges Nat. Monument, at cmpgrd, 6,500 ft, 17.vi.1983, R.T. Schuh and M.D. Schwartz, ex *P. edulis*, 15♂, 13♀ (AMNH).

Piceophylus, new genus

Figs. 7–9

Type species. *Piceophylus keltoni* Schwartz and Schuh, new species

Diagnosis. Distinguished from other Phylini by the relatively strong sexual dimorphism, male elongate and subparallel-sided, female elongate-ovate (cf., Fig. 7A, B); the uniformly shining black dorsum with fine, reclining, evenly distributed, black, simple setae (Fig. 9D); the dusky yellow antennae, labium, and legs strongly contrasting with the coloration of the body; the pretarsus with relatively elongate claw with expanded base, minute pulvillus (Fig. 9E); and the vesica C-shaped with apex elongated and tapering, secondary gonopore small and located medially (Fig. 8B). Most similar in overall appearance to dark species with pale antennae and legs, such as *Microphylellus modestus* Reuter and *M. longirostris* Knight, but the structure of the male genitalia is distinctive from the type found in *M. modestus* and *M. longirostris*, the vesica being much more similar in structure to that of *Lineatopsallus* Henry, 1991.

Description. Male (Fig. 7A). *Head*: anteocular region moderately produced and slightly rounded, gently sloping in lateral view (Fig. 9A); frons with faint transverse striations; posterior margin of vertex straight; vertex slightly convex, basal carina obsolete; width of gena and gula slightly greater than diameter of antennal segment 1; buccal cavity moderately large, subovoid; eyes large (Fig. 9A), subequal to head height in lateral view, dorsal margin produced dorsal to vertex; posterolateral margin

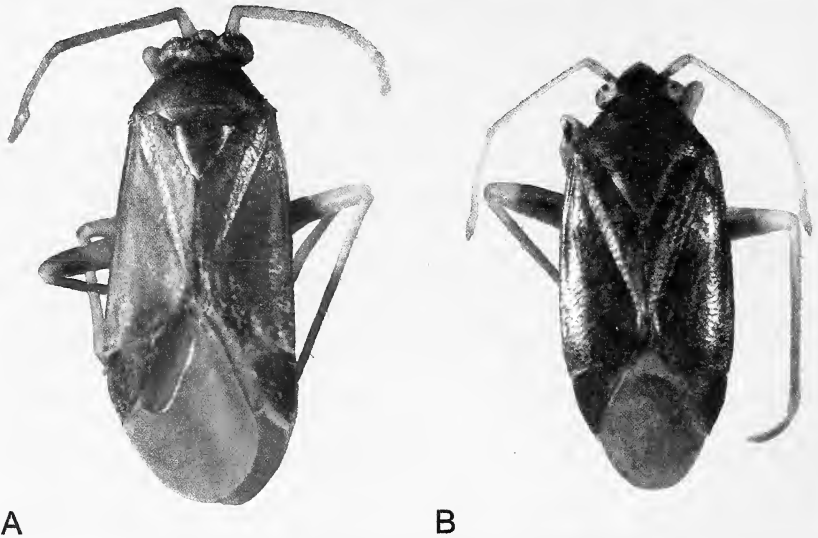


Fig. 7. Dorsal habitus photographs of *Piceophylus keltoni* Schwartz and Schuh. A. Male. B. Female.

removed from anterolateral margin of pronotum, emarginate anteriorly; antennal insertion subcontiguous to anterior margin of eye and slightly dorsal to ventral margin of eye; antenna pale yellowish orange; antennal segment 1 dark at base, slightly thickened, short; segment 2 of uniform diameter slightly less than that of segment 1, length greater than width of head across eyes; segments 3 and 4 with diameter much less than that of segments 1 and 2; labium reaching to, or slightly exceeding, apex of hind coxa. *Thorax*: pronotum conical, width two times length; lateral and posterior margins slightly concave; anterior margin sinuate medially; disk slightly convex, without distinct anterior and posterior lobes; calli slightly convex, with minute fovea medially, sometimes subconfluent; pronotum slightly flattened anterior of calli; mesoscutum broadly exposed; scutellum moderately convexly rounded; thoracic pleura subglabrous; metathoracic scent-gland evaporatory area as in fig. 9C. *Hemelytra*: moderately elongate, subparallel-sided; cuneus and membrane moderately elongate; cuneus and membrane slightly deflexed. *Venter*: with evenly distributed, reclining, pale brown, simple setae. *Legs*: tibiae without dark spots at spine bases; tibial spines pale brown. *Male genitalia*: Genital capsule: relatively small, elongate and conical, apex slightly truncate. Left paramere (Fig. 8D): small; anterior lobe gently pointed, length shorter than that of posterior lobe, posterior lobe sharply attenuate and slightly recurved. Right paramere (Fig. 8C): ovoid and pointed apically. Phallosome (Fig. 8A): moderately narrow and elongate; dorsal surface with slightly expanded aperture. Vesica (Fig. 8B): C-shaped, widest at level of secondary gonopore, sharply attenuated distal to secondary gonopore; anterior and posterior straps

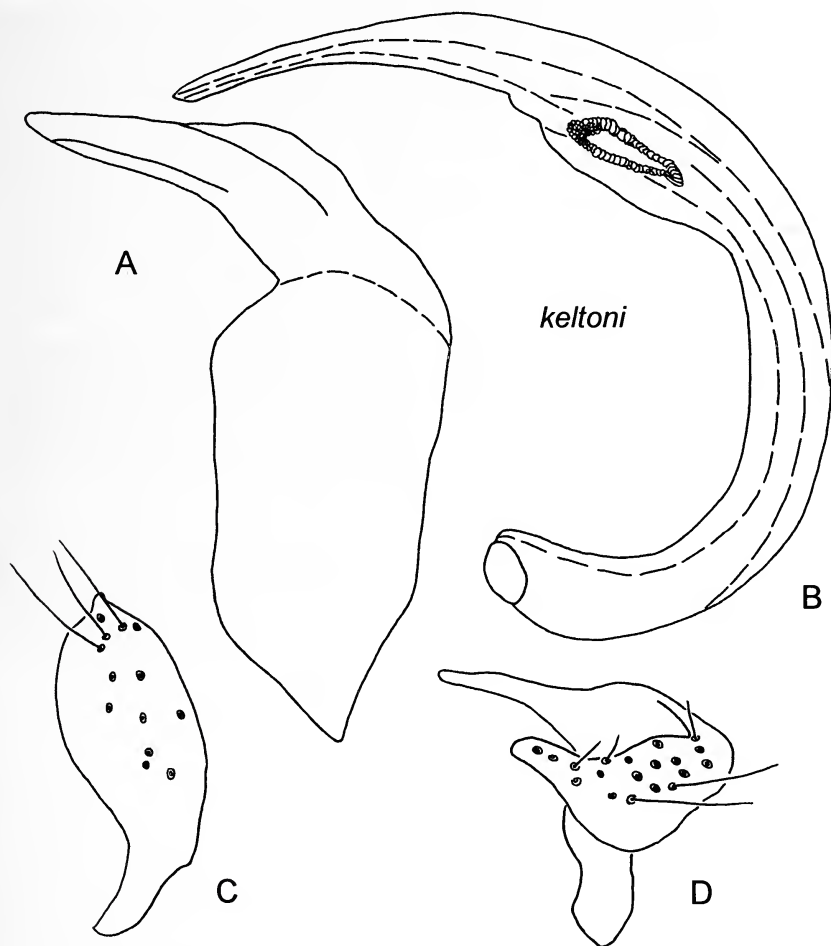


Fig. 8. Male genitalia of *Piceophylus keltoni* Schwartz and Schuh. A. Phallosome. B. Vesica. C. Right paramere. D. Left paramere.

unified basal to secondary gonopore; posterior strap terminated at level of secondary gonopore; secondary gonopore small, ovoid, situated medially on vesica.

Female (Fig. 7B). Similar to male except eyes smaller, vertex wider, diameter of antennal segment 2 distinctly smaller than in male, hemelytra slightly convex laterally, cuneal fracture at position of sixth sternite, and membrane extending slightly beyond apex of abdomen.

Etymology. Named for the apparent strict host association of the included species with *Picea* spp. (Pinaceae); masculine.

Discussion. The genus currently includes one species known from eastern North America with an apparently isolated population in the Cypress Hills of Alberta.

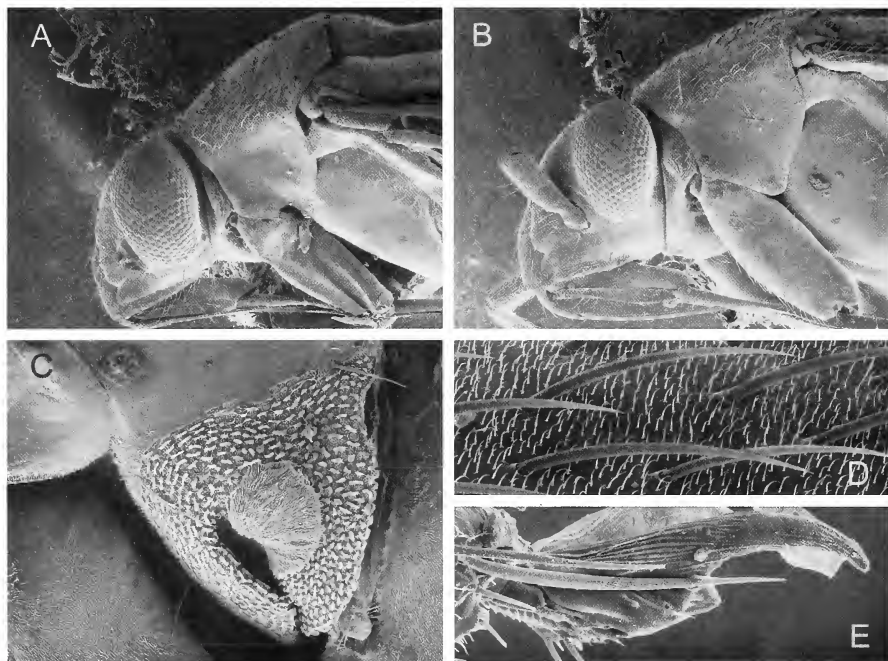


Fig. 9. Photomicrographs of *Piceophylus keltoni* Schwartz and Schuh. A. Head and propleuron, lateral view, male. B. Head and propleuron, lateral view, female. C. Ostiolar peritreme. D. Dorsal setae. E. Pretarsus, lateral view.

Piceophylus keltoni, new species

Figs. 7-9

Diagnosis. Recognized by the shining castaneous to nearly black dorsum with short, evenly distributed, fine, black, simple setae (Fig. 7A); yellowish orange legs, antennae, and labium; femora and tibia without dark spots; vesica C-shaped, with medially located secondary gonopore (Fig 8B). General appearance and coloration similar to *Microphylellus modestus*, but antennae much more strongly sexually dimorphic than in that species and the form of the vesica also distinctive.

Description. Male (Fig. 7A). Total length 4.2 (3.5-4.4); cuneus and membrane moderately long; ratio of head width across eyes to cuneus length along lateral margin 1.00:1.00 to 1.04:1.00; uniformly shining castaneous to nearly black. *Head*: width 0.76 (0.71-0.78); vertex width 0.33 (0.30-0.36); eyes large; antennae yellowish orange; base of segment 1 dark; segment 2 sometimes slightly darkened; antennal measurements 0.28 (0.25-0.30): 1.13 (0.97-1.19): 0.73 (0.70-0.83): 0.41 (0.38-0.43); labium pale, reaching to slightly exceeding apex of hind coxae, length 1.54 (1.46-1.63). *Thorax*: propleuron, mesoscutum, scutellum, and peritremal disk black. *Hemelytra*: membrane and veins infusate. *Venter*: black. *Legs*: yellowish orange; bases of coxae darkened, tibial spines yellow. *Genitalia*: see Fig. 8.

Female (Fig. 7B). Similar to male except: total length 3.5 (3.3-3.9); head width 0.74 (0.71-0.81); vertex width 0.39 (0.36-0.42); eyes smaller; antennal measurements

0.26 (0.24–0.29): 0.99 (0.87–1.09): 0.61 (0.55–0.70): 0.39 (0.38–0.40); length of labium 1.63 (1.50–1.75).

Etymology. Named for Dr. Leonard A. Kelton, former Research Scientist with Agriculture and Agri-Food Canada, who first recognized this species as new (albeit in *Microphylellus* Reuter) in an unpublished manuscript on the plant bugs of eastern Canada.

Discussion. In light of the known distribution of *Piceophylus keltoni*, we have searched the literature on Palearctic Phylinae in an attempt to determine whether it might actually be a Holarctic species. The genitalia of “*Psallus*” *holomelas* Reuter, 1906, from Szechwan, China are similar, but the coloration of that species is very different as suggested by its name (see Kerzhner, 1997:246–247).

Hosts. Primarily taken on white spruce, *Picea glauca* (Moench) Voss., but also known from *P. abies* (L.) Karst. and *Abies balsamea* (L.) Mill.

Distribution. From the Canadian Maritime Provinces east to Québec, Ontario, and the Cypress Hills of Alberta, south in the eastern United States to New Hampshire.

Holotype. ♂, “[CANADA] Yarmouth, N[ova]. S[cotia], 19-VII-1966 L.A. Kelton; on *Picea*.” Deposited in the Canadian National Insect Collection, Agriculture and Agri-Food Canada, Ottawa.

Paratypes. CANADA, **Alberta:** Cypress Hills Prov. Park, Top Rd, 1.2 km E Spruce Coulee, 16.vi.1990, M.D. Schwartz, ex *Picea glauca*, 1♂, 11♀ (CNC); Kananaskis Highway, 25.vi.1973, L.A. Kelton, ex *Salix*, 1♂ (CNC). **New Brunswick:** Edmundston, 29.vi.1966, L.A. Kelton, ex *Picea* sp., 6♂, 8♀ (CNC); Fredericton, 23.vi.1966, L.A. Kelton, 1♂ (CNC); Fredericton, Univ. New Brunswick, 27.vi.1993, A.G. Wheeler, Jr., ex *Picea glauca*, 2♀ (USNM); Kouchibouguac Nat. Park, 23.vi.1978, L.A. Kelton, ex *Picea*, 1♂, 3♀ (CNC). Nash Crk, 28.vi.1966, L.A. Kelton, 3♀ (CNC); Petersville, 5.vii.1966, L.A. Kelton, 1♀ (CNC); Shemoque, 7.vii.1966, L.A. Kelton, ex *Picea*, 9♀ (CNC). **Nova Scotia:** Bible Hill, 12.vii.1966, L.A. Kelton, 1♀ (CNC); Cape Breton Nat. Park, 22.vii.1966, L.A. Kelton, 1♀ (CNC); Halifax, 22.vii.1976, L.A. Kelton, ex *Picea*, 6♀ (CNC). Kentville: 3.vii.1976, L.A. Kelton, 1♀ (CNC); ex *Picea* sp., 1♀ (CNC); Yarmouth, 19.vii.1966, L.A. Kelton, 5♂, 12♀ (CNC). **Ontario:** Blackburn, 18.vi.1932, W.J. Brown, 2♀ (CNC); Lambeth, 29.vi.1961, Kelton and Brumpton, 5♀ (CNC); Marathon, 28.vi.1961, D. Brown, ex *Picea*, 1♀ (CNC); Ottawa, Central Experimental Farm, 7.vi.1991, M.D. Schwartz, ex *P. abies*, *P. glauca*, 6♀ (CNC). Sault St. Marie, 27.vii.1960, Kelton and Whitney, ex spruce, 1♀ (CNC); Thessalon, 1.vii.1965, W. Gagné, ex *Picea*, 1♂ (UCB). Round Barn Rd, off of Rt 17, 2.vii.1990, M.D. Schwartz, ex *P. glauca* (CNC): 5 mi E of, 1♀; 6 mi E of, 1♂, 7♀. 3 km E of jct of Rts 17 & 548, rd to Saint Josephs Island, 2.vii.1990, M.D. Schwartz, ex *Achillea* sp., 1♀ (CNC). **Prince Edward Island:** Brackley Beach, 10.vii.1966, L.A. Kelton, 1♀ (CNC); Cavendish Nat. Park, 9.vii.1966, L.A. Kelton, 1♂, 11♀ (CNC); Dalvey, 10.vii.1966, L.A. Kelton, 4♀ (CNC). **Québec:** Aylmer, 2.vii.1936, G.S. Walley, ex spruce, 1♀ (CNC); Baie-de-Gaspé-Nord, Forillon National Park, Penouile Beach, parking lot, 10 m, 20.vii.1995, M.D. Schwartz, ex *P. glauca*, 2♀ (CNC); Cap-Chat, Centre d’interprétation du vent et de la mer, parking, 16.vii.1995, M.D. Schwartz, ex *Abies balsamea*, 3♀ (CNC); Drummondville, 19.vi.1966, L.A. Kelton, 1♂ (CNC); Fabré, 5.vii.1963, L.A. Kelton, ex *Picea*, 15♀ (CNC); Lac Mondor, Ste. Flore, 24.vi.1961, E.G. Munroe, 1♀ (CNC); Ladysmith, 24.vii.1958, L.A. Kelton, 1♀ (CNC); Laniel, 7.iii.1966, L.A. Kelton, 3♂,

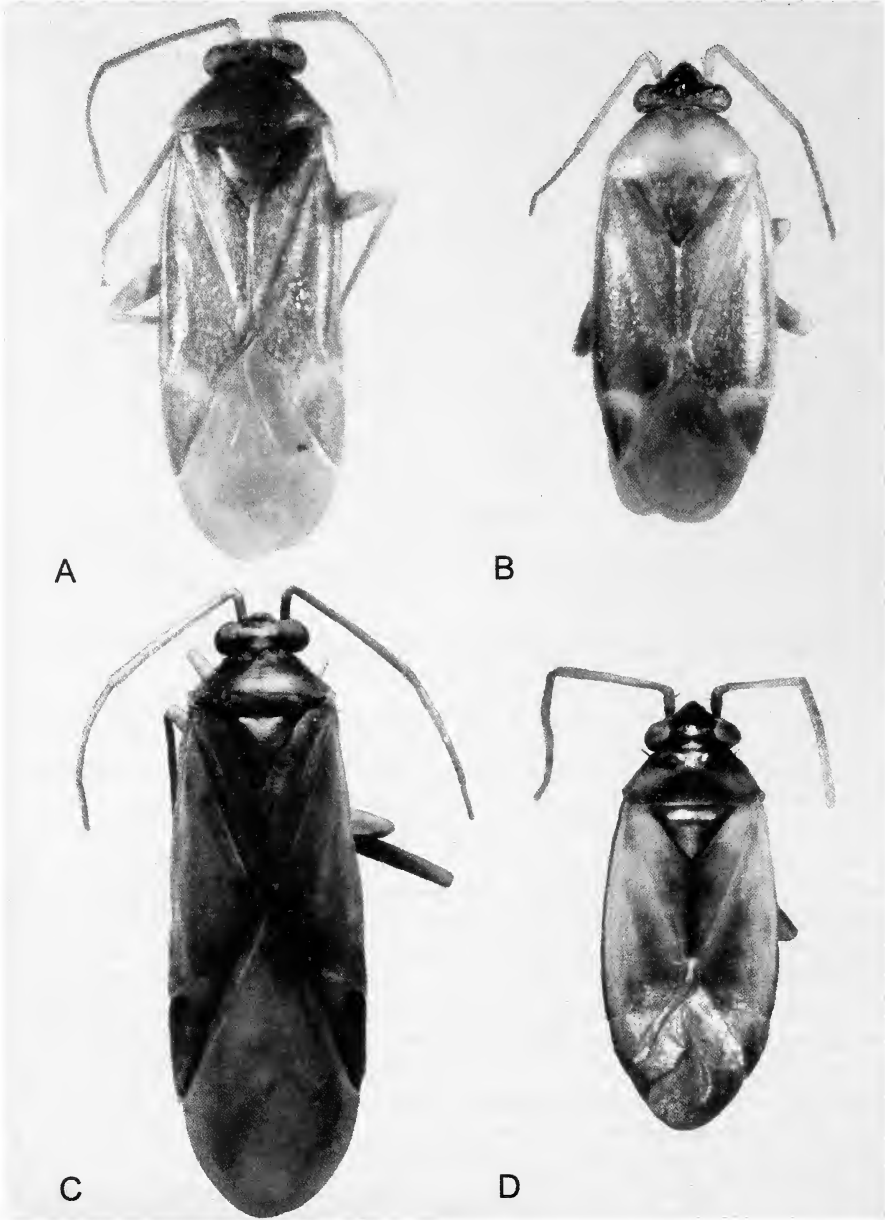


Fig. 10. Dorsal habitus photographs of *Pinophylus* spp. A, B. *P. carneolus* (Knight). A. Male. B. Female. C, D. *P. rolfsi* (Knight). C. Male. D. Female.

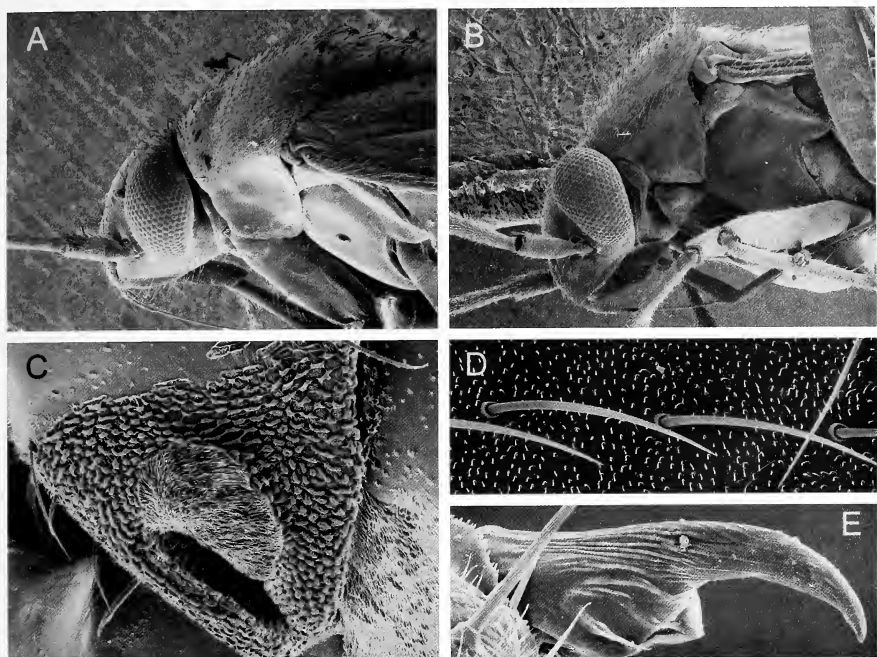


Fig. 11. Photomicrographs of *Pinophylus carneolus* (Knight). A. Head and propleuron, lateral view, female. B. Head and propleuron, lateral view of male. C. Ostiolar peritreme. D. Dorsal setae. E. Pretarsus, lateral view.

3 ♀ (CNC). USA, **New Hampshire**: *Cheshire Co.*, Mt. Monadnock, 22.vii.1954, J.A. Slater, 1 ♀ (AMNH). **New York**: *Jefferson Co.*, Watertown, A.G. Wheeler, Jr.: 10.vi.1989, taken as fifth instar, ex *P. glauca*, 24 ♂, 25 ♀ (USNM); 18.vi.1988, ex *P. glauca*, 2 ♀ (USNM). **South Dakota**: *Lawrence Co.*, Englewood, Black Hills, 5.viii.1971, L.A. Kelton, 1 ♀ (CNC). **Vermont**: *Essex Co.*, North Concord, 1,082 ft, 8.vi.1978, L.A. Kelton, ex *Picea* sp., 1 ♀ (CNC).

***Pinophylus*, new genus**

Figs. 10–15

Type species. *Plagiognathus rolfsi* Knight, 1964

Diagnosis. Distinguished from other Phylini by the following combination of characters: strongly sexually dimorphic (cf., Fig. 10C, D), the male relatively large, subparallel-sided and greatly elongate, the female elongate-ovoid and much shorter; cuneus in males greatly elongated and relatively narrow; dorsum subshining to shining ranging from largely reddish to brownish black, with inconspicuous, short, fine, reclining, evenly distributed, blackish brown, simple setae (Figs. 11D, 14D); pretarsus with relatively elongate claws with slightly expanded base, and small pulvillus (Figs. 11E, 14E). The vesica is variably shaped and cannot be easily used to characterize the group (cf., Fig. 13A, E, F). Similar in general appearance to large *Pla-*

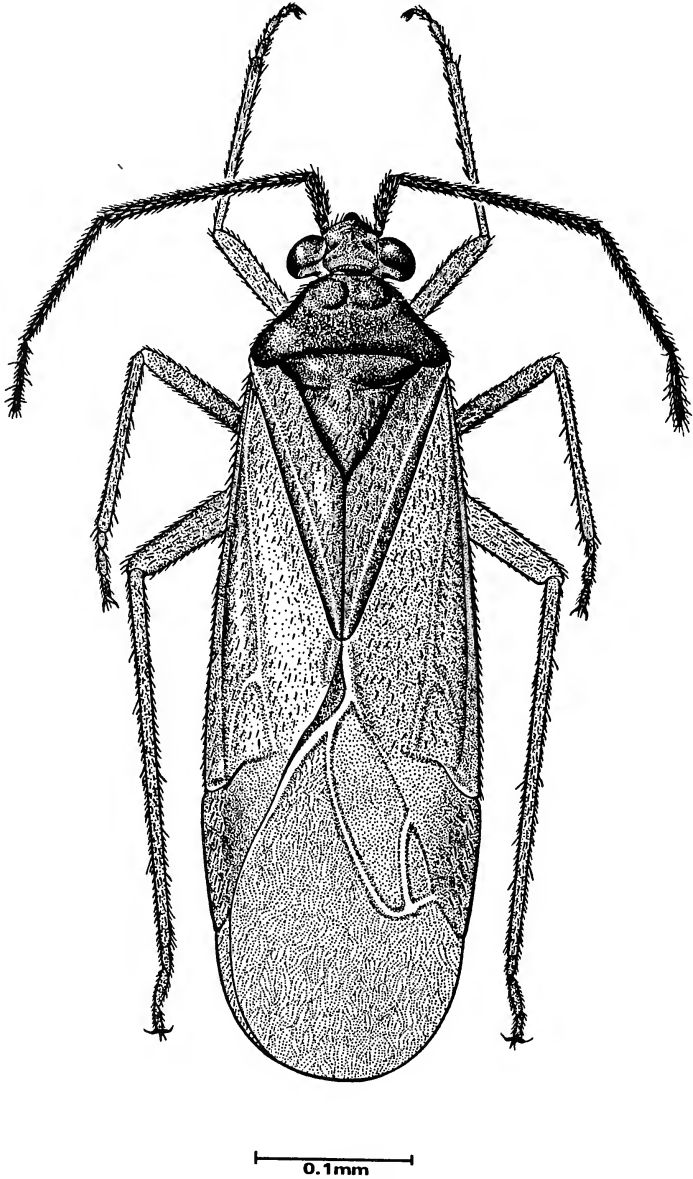


Fig. 12. Dorsal habitus illustration of *Pinophylus rolfsi* (Knight).

giognathus spp., but sexual dimorphism much stronger and structure of male genitalia unlike that of *Plagiognathus*.

Description. Male (Figs. 10A, C, 15A). *Head*: transverse, anteocular region weakly rounded and slightly produced beyond eyes in dorsal view; frons gently sloping in lateral view, with faint transverse striations; vertex flattened, posterior margin

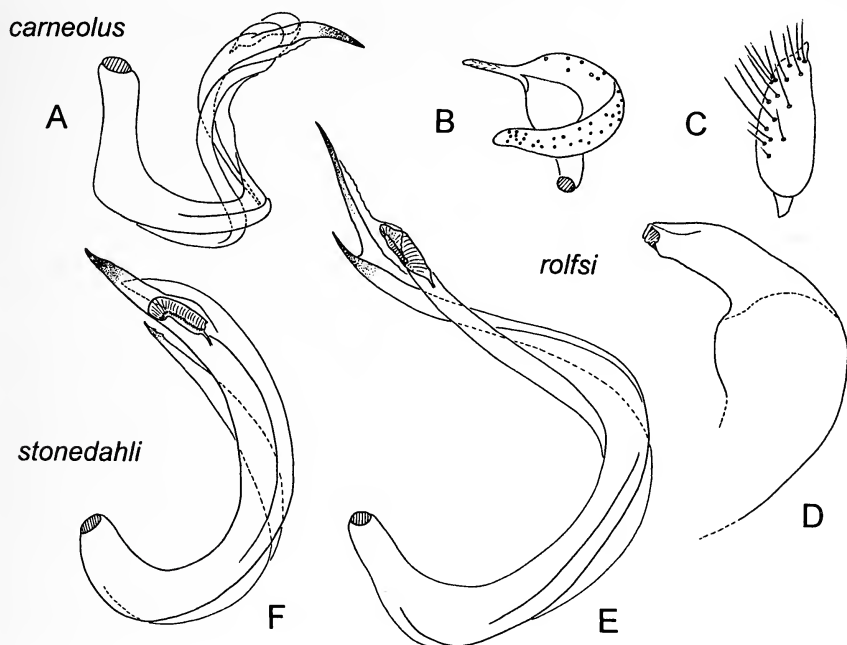


Fig. 13. Male genitalia of *Pinophylus* spp. A. *P. carneolus* (Knight), vesica. B–E. *P. rolfsi* (Knight). B. Left paramere. C. Right paramere. D. Phallosome. E. Vesica. F. *P. stonedahli* Schwartz and Schuh, vesica.

straight, basal carina obsolete; gena about as wide as diameter of antennal segment 1, gula ranging from obsolete to as long as diameter of antennal segment 1; buccal cavity moderately large, ovoid; eyes large, four-fifths head height in lateral view, dorsal margin produced dorsal to vertex, posterolateral margin removed from anterolateral margin of pronotum, emarginate anteriorly; antennal insertion subcontiguous with anterior margin of eye, insertion slightly dorsal of ventral margin of eye; antennal segment 1 short, segment 2 linear, length greater than width of head across eyes, segments 3 and 4 of diameter less than segments 1 and 2; labium reaching from apex of hind coxa to abdominal sternum 5. *Thorax*: pronotum subconical, twice as wide as long, lateral margins ecarinate, straight, posterior margin slightly concave, disk flattened, without distinct anterior and posterior lobes, calli slightly convex, sometimes subconfluent medially; mesoscutum broadly exposed; scutellum slightly convex; thoracic pleura subglabrous; metathoracic scent-gland evaporatory area as in fig. 11. *Hemelytra*: elongate, subparallel-sided; cuneus and membrane long, cuneal fracture at level of apex of genital segment and membrane extending far beyond apex of genital segment (Fig. 14C); cuneus much longer, than broad, slightly deflexed. *Venter*: with reclining, pale brown simple setae. *Legs*: tibial spines without dark spots at bases. *Male genitalia*: Genital capsule: elongate and conical. Left paramere (Fig. 13B): small, anterior lobe relatively long, length subequal to posterior lobe, posterior lobe sharply attenuate and slightly recurved.

Right paramere (Fig. 13C): subovoid with small apical point; sometimes ventral margin with slightly produced. Phallosome (Fig. 13D): relatively narrow and elongate, with slot-like aperture. Vesica (Figs. 13A, E, F): of variable shape and length, comprising two straps, gonopore subapical.

Female (Figs. 10B, D, 15B). Very different in appearance from male: head much more strongly produced beyond eyes, frons bulging in dorsal view, eyes smaller, vertex wider than in male; diameter of antennal segment 2 smaller than in male; pronotum often campanulate; body form much more robust and compact than in male, hemelytra moderately convex laterally, position of cuneal fracture equal to seventh sternite and membrane extending, at most, slightly beyond apex of abdomen. Color variation in females often much greater than in males.

Etymology. Named for the association of most known specimens with species of *Pinus* (Pinaceae); masculine.

Discussion. *Pinophylus*, like *Coniferocoris*, has a superficial appearance very much like that of many *Plagiognathus* species. It is little wonder then that Knight described *P. rolfsi* in *Plagiognathus*. Characters other than general appearance militate against placement in *Plagiognathus*, however, most prominent being the form of the male genitalia.

Pinophylus carneolus (Knight), new combination

Figs. 10A, B, 11, 13A

Plagiognathus carneolus Knight, 1927: 10 (n. sp.).

Diagnosis. Recognized by the slightly reddish brown coloration of most specimens and the form of the male genitalia, with a more strongly curving vesica (Fig. 13A) than is found in *Pinophylus rolfsi* (Fig. 13E) and *P. stonedahli* (Fig. 13F).

Redescription. Male (Fig. 10A). Moderately large species, total length 4.2 (4.0–4.3); dorsum moderately and uniformly shining reddish brown or red, base of cuneus on mesial half with a white quadrate mark; dorsum with sparsely to evenly distributed, reclining, fine, brown simple setae. **Head:** deeply red to castaneous, width 0.82 (0.79–0.84); vertex width 0.33 (0.31–0.35); antennae pale and tinged with red to weakly infusate; antennal measurements 0.26 (0.24–0.28): 1.11 (1.06–1.15): 0.57 (0.48–0.66): 0.45 (0.36–0.60); labium pale to weakly infusate, reaching to about apex of hind coxa, length 1.41 (1.28–1.49). **Thorax:** mesoscutum and scutellum reddish brown, pleuron red, including metathoracic scent-gland evaporatory area. **Hemelytra:** membrane and veins infusate. **Venter:** pale with some red. **Legs:** pale to weakly infusate, base of coxae often darker. **Genitalia:** see Figs. 13A.

Female (Fig. 10B). Body form elongate ovoid, much more compact than in male; hemelytra relatively short, nearly conforming to shape of abdomen, cuneus short, length and width subequal. Total length 3.8 (3.72–3.86); head width 0.81 (0.79–0.83); vertex width 0.38 (0.37–0.39); eyes smaller than in male; antennal measurements 0.24 (0.23–0.25): 0.95 (0.92–1.00): 0.61 (0.56–0.65): 0.38 (0.36–0.40); labium reaching to apex of metacoxa, length 1.49 (1.49–1.59).

Host. Breeds on Virginia pine, *Pinus virginiana* Mill., appearing early in the season (Knight 1927).

Distribution. Reported from District of Columbia, Maryland (east central) Pennsylvania, Virginia and Wisconsin (Henry and Wheeler 1988) and West Virginia (Wheel-

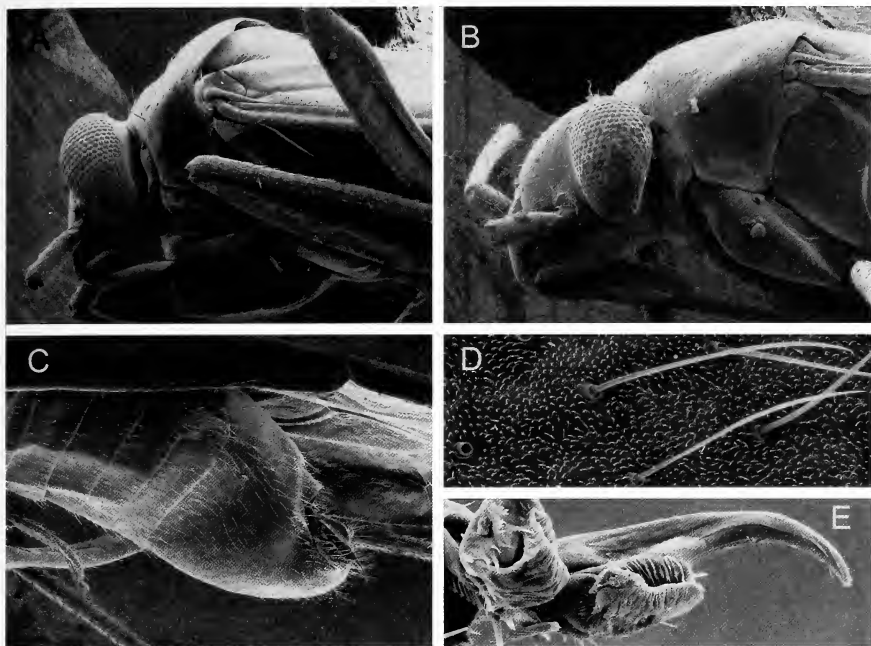


Fig. 14. Photomicrographs of *Pinophylus rolfsi* (Knight). A. Head and propleuron, lateral view, male. B. Head and propleuron, lateral view of female. C. Genital capsule, male. D. Dorsal setae. E. Pretarsus, lateral view.

er, et al. 1988, pg. 137). The Wisconsin record could not be verified. For new records, including North Carolina, see Wheeler (1999, this issue).

Discussion. The placement of *carneolus* in *Pinophylus* is based heavily on the sexual dimorphism which is of the same type found in *P. rolfsi* (Knight) and *P. stonedahli*, new species. The genitalia are heterogeneous among these three species and by themselves do not offer a single distinctive feature diagnostic for *Pinophylus*. The distribution might be considered somewhat unusual among North American Phylinae, in that many genera which are speciose in the west and which do not also have representatives at higher latitudes do not have representatives in the eastern United States. Nonetheless, *P. carneolus* shows much greater affinity with the western *Pinophylus* species than with *Plagiognathus*, the genus in which it was originally described, on the basis of head structure, sexual antennal dimorphism, and overall sexual dimorphism. We have therefore placed it in *Pinophylus*. Furthermore, the genitalia are not of the *Plagiognathus* type.

Material examined. USA, **Maryland:** Anne Arundel Co., Odenton, 5.v.1918, W.L. McAtee, ex *Pinus virginiana*, 1♂ (CNC). **Virginia:** Arlington Co., E of Falls Church, 13.v.1911, S.A. Rohwer, 1♂ (USNM). We have examined 41 additional specimens from Maryland, North Carolina, Pennsylvania, and Virginia which are listed in Wheeler (1999, this issue).

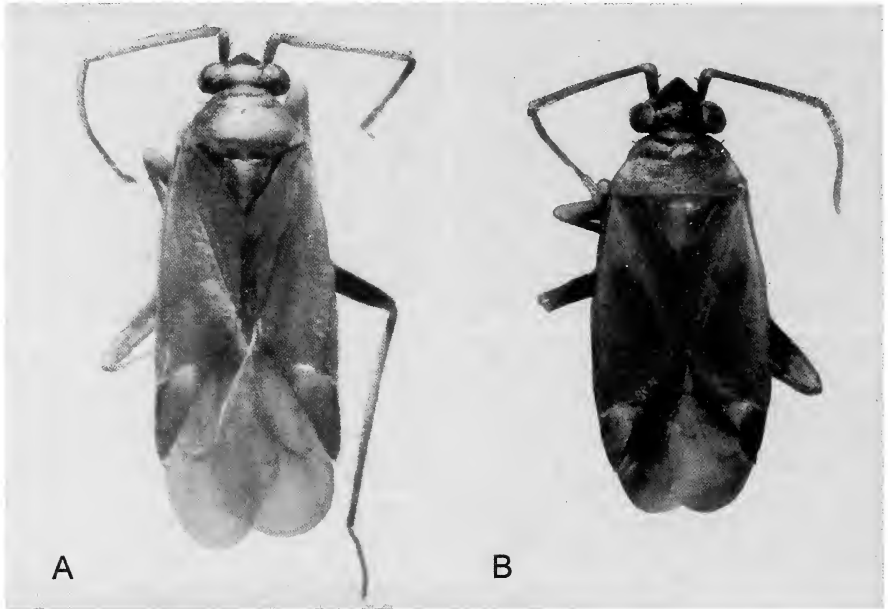


Fig. 15. Dorsal habitus photographs of *Pinophylus stonedahli* Schwartz and Schuh. A. Male. B. Female.

Pinophylus rolfsi (Knight), new combination

Figs. 10C, D, 12, 13B-E, 14

Plagiognathus rolfsi Knight, 1964: 145 (n. sp.).

Diagnosis. Most easily distinguished from *P. stonedahli* by the J-shaped vesica, with distal portion extending beyond level of vesical base and attributes of apical spines (Fig. 13E). Males easily distinguished from *P. carneolus* by their brownish black rather than reddish coloration.

Redescription. Male (Figs. 10C, 12). Total length 5.2 (4.6–5.2); ratio of head width across eyes to cuneus length along lateral margin 1.00:0.86 to 1.00:1.28; uniformly shining blackish brown, sometimes base of cuneus with reddish infuscation; dorsum with sparsely to evenly distributed, reclining, fine brown simple setae. *Head*: brownish black, including vertex; width 0.81 (0.78–0.85); vertex width 0.32 (0.30–0.33); antennae yellowish brown to brown; segments 3 and 4 dusky yellow; antennal measurements 0.30 (0.30–0.31): 1.29 (1.24–1.35): 0.93 (0.90–0.95): 0.48 (0.45–0.50); labium brown, reaching apex of, to extending slightly beyond, hind coxa, length 1.65 (1.60–1.68). *Thorax*: propleura, mesoscutum, scutellum, and peritremal disk brownish black. *Hemelytra*: base of cuneus usually dark reddish brown, sometimes small males with base of cuneus slightly pale white; membrane and veins infuscate. *Venter*: black. *Legs*: yellowish brown to brown; sometimes fore coxa and apical portion of other coxae pale white. *Genitalia*: see Fig. 13B–E.

Female (Fig. 10D). Total length 3.9 (3.6–4.5); head width 0.84 (0.80–0.93); vertex width 0.41 (0.39–0.45); eyes smaller; antennal measurements 0.30 (0.29–0.33): 1.22

(1.08–1.38): 0.84 (0.80–0.90): 0.44 (0.43–0.45); labium brown, reaching apex of hind coxa to middle extending to middle of abdomen, length 1.94 (1.80–2.20).

Discussion. Over the range of this species total body length and length of the antennal segment 2 and labium show considerable variation, which initially suggested to us that the specimens examined represented more than one species. Although the length and shape of the distal portion of the vesica also exhibits some variation, we did not find any consistent differences which would allow us to recognize more than one species.

Hosts. Most commonly found on species of *Pinus*, but also known to occur on *Abies*, *Picea*, and *Pseudotsuga* spp.

Distribution. Southern Alaska and the Yukon, south through British Columbia, to Oregon and east to Colorado.

Material examined. CANADA, **Alberta:** Kananaskis Highway, 25.vii.1973, L.A. Kelton, 1 ♀ (CNC); Lake Louise, 3.viii.1970, L.A. Kelton, 5 ♀ (CNC). **British Columbia:** Anarchist Mtn, Osoyoos, 13.vii.1970, L.A. Kelton, 1 ♀ (CNC); Blackwall Peak Area, Naturalist Hut, Manning Prov. Park, alpine meadow, 19.viii.1998, M.D. Schwartz, ex *Pinus albicaulis*, 4 ♀ (UBC); Blackwall, Manning Prov. Park, 23.vii.1970, L.A. Kelton, ex *P. albicaulis*, 25 ♂, 18 ♀ (CNC). Fenton Lake, Tweedsmuir Prov. Park, W.A. Low (UBC): 27.vii.1963, 1 ♀; 15.viii.1963, 1 ♀ (UBC). Fraser, 29.vii.1982, G.G.E. Scudder, 2 ♀ (CNC); Mount Revelstoke Nat. Park, 30.vii.1970, L.A. Kelton, ex *Abies lasiocarpa*, 1 ♂, 2 ♀ (CNC); Mount Kobau, Osoyoos, 13.viii.1997, G.G.E. Scudder, ex *A. lasiocarpa*, 1 ♀ (UBC); Rossland, 9.viii.1970, L.A. Kelton, 1 ♀ (CNC). Summerland, L.A. Kelton (CNC): 2.vii.1974 2 ♀; 24.vi.1975, ex *Pseudotsuga menziesii*, 1 ♀; 10 mi W of, 12.vii.1974, 1 ♀. Summit Lake, 16.viii.1982, L.A. Kelton, ex *Pinus contorta*, 7 ♀ (CNC); Yoho Nat. Park, 16.vii.1970, L.A. Kelton, 12 ♀ (CNC). **Yukon Territory:** Alaska Highway, mi 783, 19.vii.1961, ex *P. contorta*, 1 ♀ (CNC); Boundary, 19.8 km E, 11.vii.1983, G.G.E. Scudder, 1 ♂ (UBC); Calumet, 9.viii.1963, ex *A. lasiocarpa*, 1 ♀ (CNC); Dawson, 21.vii.1982, L.A. Kelton, 1 ♂ (CNC); Destruction Bay, 26.vii.1982, L.A. Kelton, ex *Picea* sp., 7 ♀ (CNC); McRae, 4.viii.1960, ex *P. glauca*, 1 ♀ (CNC); Moose Crk, 18.vii.1982, L.A. Kelton, 1 ♀ (CNC); Rancheria, 11.vii.1982, L.A. Kelton, ex *Pinus contorta*, 10 ♀ (CNC); Tagish, 17.vii.1983, L.A. Kelton, 1 ♀ (CNC). USA, **Colorado:** Chaffee Co., Monarch Pass, San Isabel Nat. For., 10,500 ft, 28.viii.1968, L.A. Kelton, ex *P. contorta*, 4 ♀ (CNC). Clear Creek Co.: Juniper Pass: on Rt 103, 10,500 ft, 21.viii.1986, R.T. Schuh and J.T. Polhemus, ex *P. aristata*, 10 ♀ (AMNH); picnic grounds, 11,000 ft, 7.viii.1987, T.J. Henry, ex *P. aristata*, 4 ♂, 1 ♀. Mt Goliath area: 11,200 ft, 7.viii.1987, D.A. and J.T. Polhemus, ex *P. aristata*, 3 ♂ (JTPC); 21.viii.1986, R.T. Schuh, J.T. and D.A. Polhemus, ex *P. aristata*, 22 ♂, 52 ♀ (AMNH); below, 11,500 ft, 7.viii.1987, T.J. Henry, ex *P. aristata*, 9 ♂, 18 ♀ (USNM). Mt Evans, 11,000 ft, 21.viii.1982, J.T. Polhemus, 7 ♂, 8 ♀ (JTPC); Squaw Pass Rd, 21.viii.1984, J.T. and D.A. Polhemus, ex *P. contorta*, 6 ♀ (JTPC); West Chicago Crk, Arapaho Nat. For., 9,800 ft, 28–29.vii.1968, L.A. Kelton, ex *P. contorta*, 6 ♀ (CNC). Gilpin Co., Rollinsville, Roosevelt Nat. For., 1.viii.1968, L.A. Kelton, ex *P. contorta*, 1 ♀ (CNC). Grand Co., 3 mi SE of Fraser, St. Louis Crk Cmpgnd, 8,800 ft, 28.vii.1967, F. P., and M. Rindge, 1 ♀ (AMNH). Gunnison Co., Taylor Park, 25.vii.1982, J.T. Polhemus, 5 ♀ (JTPC). Park Co., Geneva Park, Grant, 10,000 ft, 7.viii.1914, F.C. Jackson, 2 ♀ (USNM). Pitkin Co., Aspen White River Nat. For.,

24.viii.1968, L.A. Kelton (CNC): ex *P. contorta*, 2♀; ex *Picea* sp., 1♀. *Summit Co.*: Loveland Pass Summit, 12,000 ft, 7.viii.1961, C.H. Mann, 1♀ (CNC). Vail Pass summit, 10,350 ft, 11.viii.1987, ex *P. flexilis*: J.T. and D.A. Polhemus, 3♀ (JTPC); T.J. Henry, 3♀ (USNM). 8.7 mi W jct Hwy 91 on I-70, 14.viii.1980, G.M. Stonedahl, ex *P. contorta*, 1♀ (AMNH). *Weld Co.*, Brainard Lake, Roosevelt Nat. For., 10,300 ft, 2.viii.1968, L.A. Kelton, ex *P. flexilis*, 9♂, 24♀ (CNC). **Idaho**: *Bear Lake Co.*, Bloomington Lake, 24.vii.1982, M.D. Schwartz, ex *A. engelmanni*, 1♀ (AMNH). *Lemhi Co.*, 3 mi W of Gilmore, Meadow Lake Cmpgnd, 9,600 ft, 31.vii.1994, M.D. Schwartz, ex *P. albicaulis*, 3♂, 7♀ (CNC). **Oregon**: *Clackamas Co.*, 1 mi S of Government Camp, 25.vii.1966, W. Gagné, J. Haddock, ex *P. contorta*, 1♀ (UCB). *Deschutes Co.*, 6 mi SW Sisters on FS Rd 1536, 29.vii.1980, M.D. Schwartz, ex *P. ponderosa*, 1♂ (AMNH). *Grant Co.*, Wildcat Springs Cmpgrd, T14S R33E Sec 10, 21.vii.1979, M.D. Schwartz, ex *P. contorta*, 1♀ (AMNH). *Hood River Co.*, Mt Hood, Cloud Cap, 6,000 ft, 5.ix.1979, G.M. Stonedahl, ex *P. contorta*, 1♀ (AMNH). *Lane Co.*, Willamette Nat. For., Hand Lake Trail, 4,750 ft, 29.vii.1979, M.D. Schwartz, 5♀ (AMNH). *Linn Co.*, Willamette Nat. For., Mowich Lake, 5,000 ft, 8.vii.1979, M.D. Schwartz, ex *P. contorta*, 1♂, 2♀ (AMNH). **Utah**: *Salt Lake Co.*, Alta (rd to cmpgrd), 10,000 ft, 8.viii.1982, M.D. Schwartz, ex *Picea engelmanni*, 1♀ (AMNH). **Washington**: *Whatcom Co.*, Mt Baker Nat. For., R9E T39N Sec 17, 7.ix.1979, G.M. Stonedahl, ex *A. amabilis*, 1♀ (AMNH). *Yakima Co.*: Mt Adams, A.R. Rolfs (USNM): 15.vii.1932, holotype♂, allotype♀, 1♂, 6♀ paratypes; 3.viii.1930, 1♂.

***Pinophylus stonedahli*, new species**

Figs. 13F, 15

Diagnosis. Definitively distinguished from small specimens of *Pinophylus rolfsi* by the vesica, which is stout, C-shaped and with a short portion distal to the secondary gonopore. Usually recognizable by the whitish translucent base of the cuneus, and the shorter cuneus and hemelytral membrane. In *P. rolfsi* the cuneal base is usually suffused with red and the cuneus and membrane are longer. Males easily distinguished from *P. carneolus* by their brownish black rather than reddish brown coloration.

Description. Male (Fig. 15A). Total length 4.1 (4.0–4.5); ratio of head width across eyes to cuneus length along lateral margin 1.00:1.33; uniformly shining blackish brown, sometimes base of cuneus pale white or translucent; dorsum with sparsely to evenly distributed, reclining, fine, brown, simple setae. *Head*: brownish black; width 0.82 (0.80–0.86); vertex width 0.33 (0.28–0.34); antennae brown; antennal measurements 0.28: 1.15 (1.10–1.25): 0.93: 0.45; labium brown, reaching apex of hind coxa to slightly beyond, length 1.65 (1.64–1.66). *Thorax*: propleura, meso-scutum, and scutellum, and peritremal disk brownish black. *Hemelytra*: membrane and veins infuscate. *Venter*: black. *Legs*: uniformly dark orange brown to brown. *Genitalia*: see Fig. 13F; ventral margin of right paramere slightly expanded. *Female* (Fig. 15B). Total length 3.6 (3.5–3.7); head width 0.78 (0.75–0.83); vertex width 0.39 (0.38–0.42); antennal measurements 0.27 (0.25–0.28): 0.98 (0.95–1.15): 0.68 (0.65–0.70): 0.38; labium brown, reaching base of ovipositor, length 1.83 (1.80–1.84).

Etymology. Named for our good friend and colleague Dr. Gary M. Stonedahl, who collected some of the specimens upon which the description of this species is based.

Discussion. *Pinophylus stonedahli* itself shows little size variation in the available sample, but is practically indistinguishable from small specimens of the highly variable *P. rolfsi*, without examination of the male vesica.

Hosts. Only taken on limber pine, *Pinus flexilis* James.

Distribution. The Beartooth and Wind River Mountains of southern Montana and northern Wyoming.

Holotype. ♂, “USA, **Montana**, Carbon County, Rock Creek Vista Pt. on Rt. 212, NE of Beartooth Summit, 9,100 feet, August 11, 1986, Schwartz and Stonedahl; on *Pinus flexilis* James (Pinaceae).” Deposited in the American Museum of Natural History, New York.

Paratypes. USA, **Montana**: *Carbon Co.*: same as for holotype, 10♂, 10♀ (AMNH).

Wyoming: *Sublette Co.*: Wind River Mts., 20 mi N of Pinedale, 10,200 ft, 16.viii.1981, M.D. Schwartz, ex *P. flexilis*, 1♂, 12♀ (AMNH); Big Sandy Trailhead, Billy Lake, 24.viii.1981, M.D. Schwartz, ex *P. flexilis*, 1♂, 48♀ (AMNH); Elkhart Park Trail to Hobbs Lake, Wind River Mtns, 20 mi N of Pinedale, 10,200 ft, 16.viii.1981, ex *P. flexilis*, 1♂ (AMNH); 25 mi SE Jackson, Hobart River, 27.vi.1966, W. Gagne, J. Haddock, 1♀ (UCB). *Teton Co.*, Teton Nat. Park, 31.vii.1931, H.H. Knight, 1♂ (USNM).

Additional specimens. USA, **Wyoming**: *Park Co.*, Yellowstone Nat. Park, 4.viii.1931, H.H. Knight, 3♀ (USNM).

Psallovius Henry

Psallovius Henry 1999: 107.

Diagnosis. Distinguished from other small brown Phylini by the overall shining dark coloration with basal margin of cuneus pale (Figs. 16A, B, 17); the slender pale or black antennae; the dorsum and thoracic pleura with evenly distributed, recumbent, silvery white, scale-like setae and reclining, longer, shining, brown, simple setae; the pretarsus with long claws with narrow base, minute pulvilli and long setiform par-empodia; and the J-shaped vesica with minutely spinose distal region of the terminal secondary gonopore. The general appearance and coloration are most similar to those of *Ranzovius* Distant, but *Psallovius* differs by the much more slender antennal segment 2, the shorter anterior and ventral portion of the head, and the longer more curved claws.

Discussion. Henry (1999) described *Psallovius* to accommodate the type species, *Psallus piceicola* Knight, *P. flaviclavus* (Knight), and *P. rubrofemoratus* (Knight). Two additional species, described below, are now known to occur in western North America.

Biology. Breeds on conifers, including species of *Abies*, *Picea*, *Pinus*, and *Pseudo-tsuga*.

KEY TO SPECIES OF *PSALLOVIUS*

- 1. Length of antennal segment 2 less than width of head across eyes 2
- Length of antennal segment 2 usually greater than width of head across eyes; sometimes equal to width 3

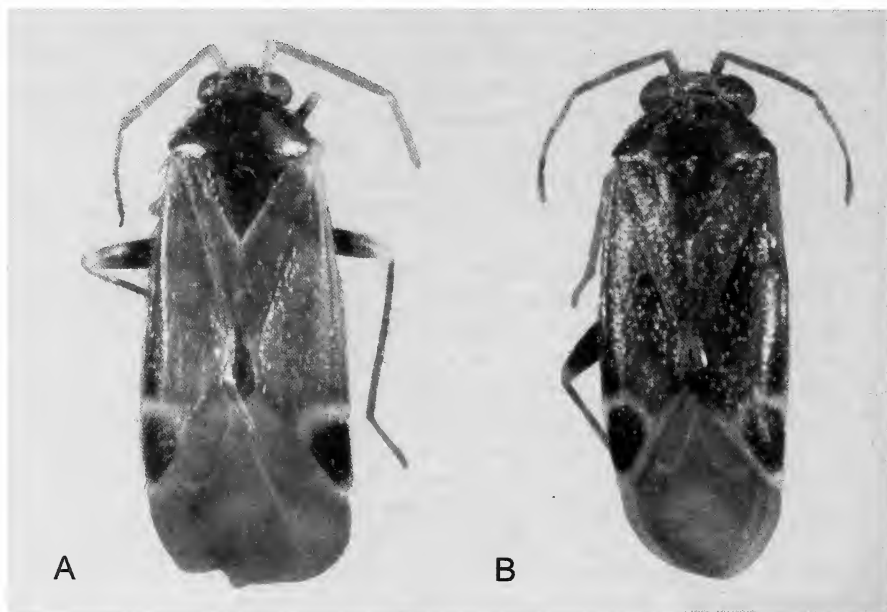


Fig. 16. Dorsal habitus photographs of male *Psallovius* spp. A. *P. dimorphicus* Schwartz and Schuh. B. *P. nigroantennatus* Schwartz and Schuh.

2. Antennal segment 1 and 2 black; base of cuneus narrowly pale or translucent; hemelytra always uniformly dark *nigroantennatus*, n.sp.
- Antennal segment 1 and 2 pale; base of cuneus broadly pale or translucent; hemelytra sometimes paler mesially on clavus and corium *flaviclavus* (Knight)
3. Body length of male greater than 3.50 mm; antennal segment 2 long, 0.78–0.90 mm, ratio of segment 2 to width of head across eyes from 1.20–1.30: 1 *dimorphicus*, n.sp.
- Body length of male less than or equal to 3.20 mm; antennal segment 2 long, 0.58–0.76 mm, antennal segment 2 shorter, ratio of segment 2 to width of head across eyes from 1.00–1.18: 1 4
4. Femora, except for pale apices, bright red *rubrofemoratus* (Knight)
- All femora, except for pale apices, dark brown to black *piceicola* (Knight)

***Psallovius dimorphicus*, new species**

Figs. 16A, 18A

Diagnosis. Distinguished by the great sexual dimorphism of hemelytra, cuneus, and membrane; the long antennal segment 2; the relatively wide head; the dark brown dorsum with slightly paler corium; and the long apex of the vesica adjacent to the secondary gonopore of the vesica.

Description. Male (Fig. 16A). Elongate, parallel-sided, total length 3.7 (3.2–4.0) mm, dorsum including cuneus dark brown, with apices of emboliar margin, corium, and cuneus and crescent-shaped base of cuneus pale; vestiture with silky, silvery white scale-like setae and shining, brown simple setae. **Head:** dark brown, relatively narrow; width 0.67 (0.65–0.70); vertex width 0.28 (0.26–0.30); eyes large, antennal

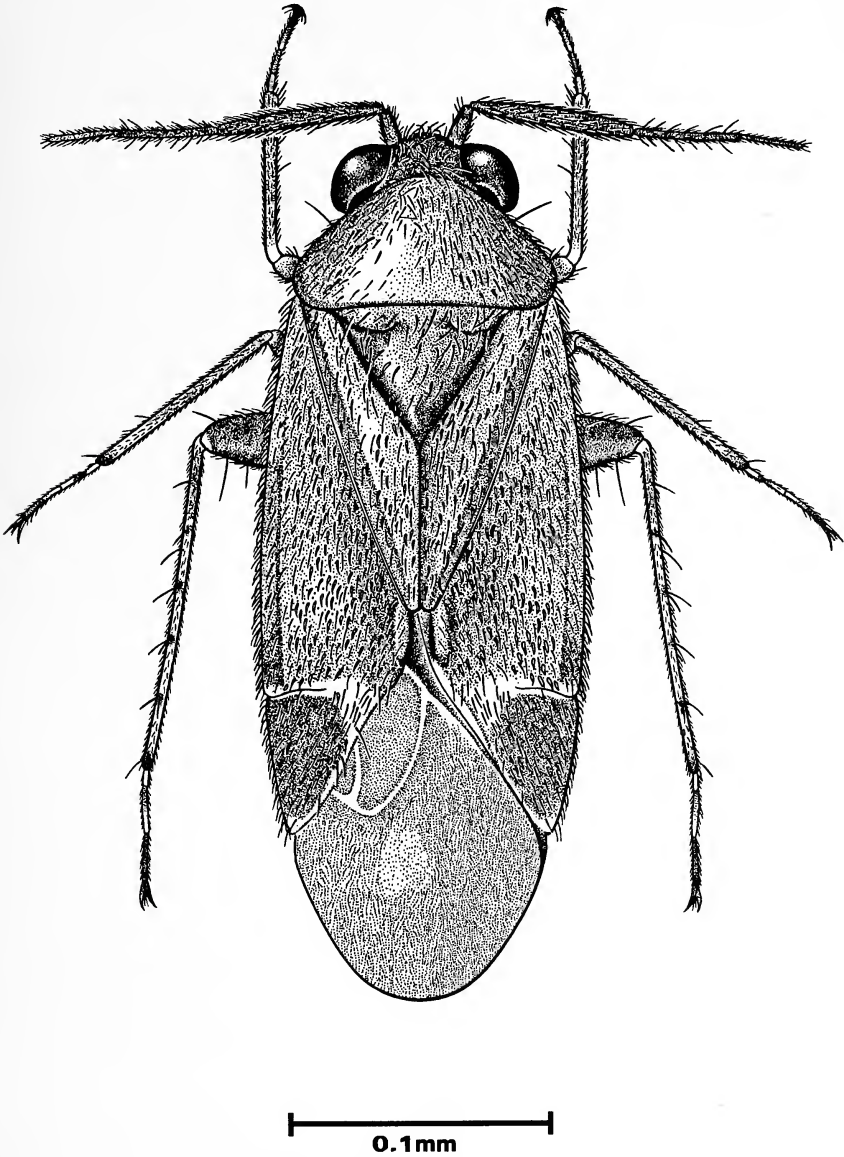


Fig. 17. Dorsal habitus illustration of *Psallovius nigroantennatus* Schwartz and Schuh.

socket contiguous with and dorsal to ventral margin of eye; antenna pale yellow, segments 3 and 4 brown; sometimes segments 1 and 2 dusky yellow basally; segment 2 linear; antennal measurements 0.25 (0.23–0.28): 0.82 (0.78–0.90): 0.50 (0.38–0.56): 0.29 (0.25–0.33); labium pale to dusky yellow, segment 1 and 4 usually dark brown, reaching or slightly exceeding hind coxa, rostral length 1.27 (1.21–1.35).

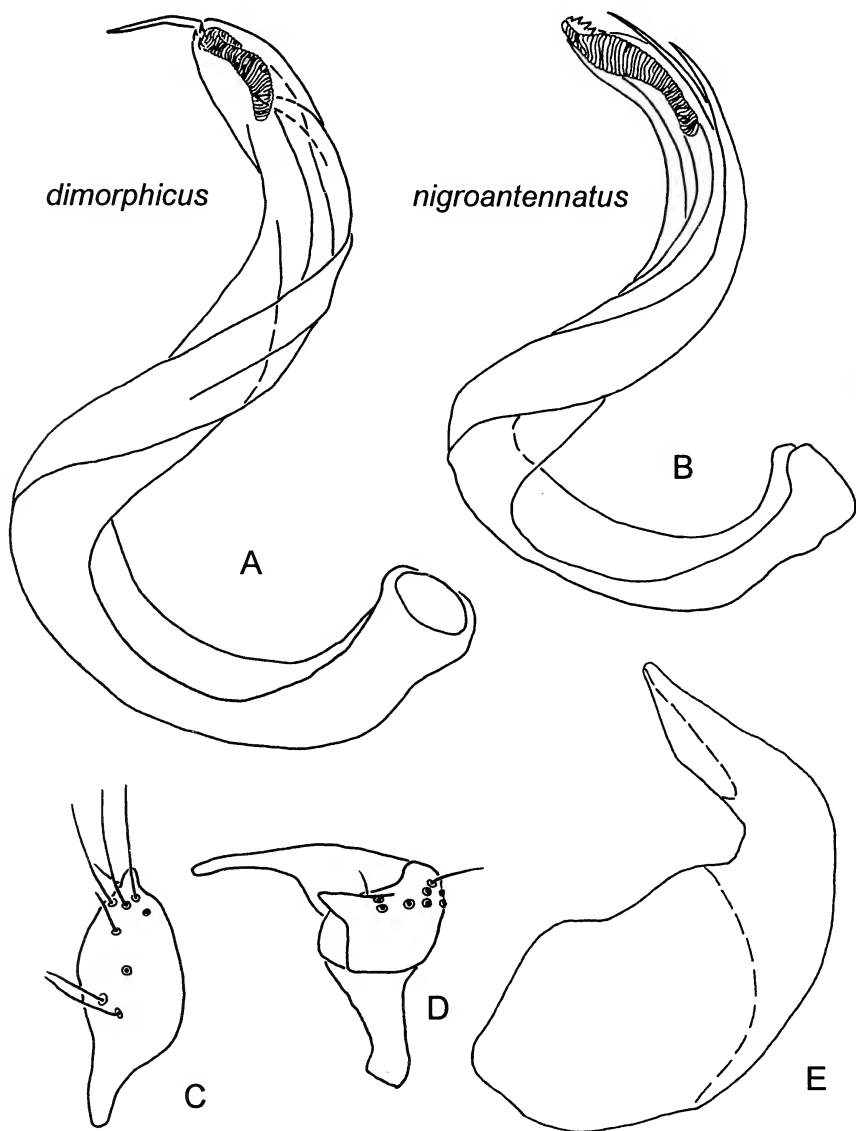


Fig. 18. Male genitalia of *Psallovius* spp. A. *P. dimorphicus* Schwartz and Schuh, vesica. B-E. *P. nigroantennatus* Schwartz and Schuh. B. Vesica. C. Right paramere. D. Left paramere. E. Phallosome.

Thorax: mesoscutum, and scutellum dark brown, peritremal disk brown except anterior lobe pale. **Hemelytra:** dark brown, base and apex of cuneus pale; membrane infusate with large pale areas, veins pale, small areole with red veins. **Venter:** black. **Legs:** black, extreme apex of femora pale; tibia pale to dusky yellow, sometimes

base darkened, tibial spines black with obscure dark spots at bases. *Genitalia*: see Fig. 18A.

Female. Hemelytra shorter, otherwise similar to male except: total length 3.0 (2.9–3.2); head width 0.65 (0.63–0.68); vertex width 0.33 (0.31–0.33); antennal measurements 0.24 (0.23–0.25): 0.68 (0.64–0.73): 0.50 (0.43–0.53): 0.31 (0.28–0.33); labium 1.28 (1.25–1.34).

Etymology. Named for sexual dimorphism of the corium and antennal segment 2.

Hosts. Collected on *Abies* spp. (*A. concolor*, *A. lasiocarpa*), *Picea* (Engelmann spruce, *P. engelmanni* Parry ex Engelm., blue spruce, *P. pungens* Engelm.), and *Pinus contorta*.

Distribution. Montane areas in central Idaho and Montana south through Colorado and Utah to Arizona and New Mexico.

Discussion. The longer hemelytra, antennal segment 2, and genital segment, the usually wider vertex, head, and pronotum, the apex of the vesica greatly exceeding the secondary gonopore, and the western montane distribution will distinguish *Psallolovius dimorphicus* from the more widely distributed species, *P. piceicola* (Knight).

Holotype. ♂, “USA, Utah, Uintah Co., Kane Hollow on Red Cloud Loop, T1S R21E, el 8,500 ft, Sept. 7, 1982, coll. M.D. Schwartz; ex *Picea engelmanni*.” Deposited in the American Museum of Natural History, New York.

Paratypes. USA, **Arizona:** *Apache Co.*: Eagar, Apache Nat. For., 12.vii.1967, L.A. Kelton, ex *Picea* sp., 5♂, 6♀ (CNC); 9 mi N of Hwy 260 on FR 117, 19.ix.1998, J.C. Schaffner, 1♂, 4♀ (TAM). *Cochise Co.*, Trail to Rustler Park to Fly Peak, Chiricahua Mtns 31.viii.1976, J.D. Pinto, 4♂, 6♀ (UCR). *Coconino Co.*, Humphreys Peak, Flagstaff, 16.viii.1967, L.A. Kelton, ex *A. concolor*, 13♂, 13♀ (CNC). *Greenlee Co.*: FR 25, 0.5 mi NW of Hwy 191, 33°35'13"N 109°21'49"W, 9,160 ft, 19.viii.1998, J.C. Schaffner, 20♂, 32♀ (TAM); 2.7 mi NE of Hannagan Meadow, 33°38'59"N 109°16'58"W, 8,630 ft, 19.viii.1998, J.C. Schaffner, 1♂, 2♀ (TAM). **Colorado:** *Boulder Co.*: Nederland, 31.viii.1972, L.A. Kelton, ex *Pinus* sp., 1♀ (CNC); Ward, Roosevelt Nat. For., 30.vii.1968, L.A. Kelton, ex white pine, 1♂ (CNC). *Chaffee Co.*: Cottonwood Pass, 1.ix.1980, 12,125 ft, J.T. Polhemus, 1♂, 1♀ (JTPC); Poncha Springs, 28.viii.1968, L.A. Kelton, ex *P. edulis*, 2♂, 3♀ (CNC). *Clear Creek Co.*: Green Lake, Guanella Pass, 6.ix.1982, 9,900 ft, D.A. and J.T. Polhemus, 1♂, 3♀ (JTPC); Idaho Springs, 30.vii.1968, L.A. Kelton, ex *Picea* sp., 1♂ (CNC). *Gilpin Co.*: East Portal, Roosevelt Nat. For., 31.viii.1972, L.A. Kelton, ex *Picea* sp., 2♂, 1♀ (CNC); Rollinsville, Roosevelt Nat. For., 2.ix.1972, L.A. Kelton, ex *Pinus flexilis*, 1♂ (CNC). *Grand Co.*: Fraser, 5.3 mi S of, on Hwy 40, 17.viii.1980, G.M. Stonedahl, ex *A. lasiocarpa*, 5♂, 5♀ (AMNH); St. Louis Cmpgrd, 3.4 mi W of Fraser, 16.viii.1980, G.M. Stonedahl, ex *P. contorta*, 1♂, 4♀ (AMNH). *Gunnison Co.*, Lost Lake, Gunnison Nat. For. 27.viii.1968, 9,500 ft, L.A. Kelton, *Picea* sp., 4♂, 6♀ (CNC). *Jefferson Co.*, Buffalo Crk, 5 mi W of, 5.ix.1982, D.A. and J.T. Polhemus, ex *P. pungens*, 1♂ 1♂ (JTPC). *Larimer Co.*: Fall River Rd, Rocky Mtn Nat. Park, 16.viii.1968, 9,500 ft, L.A. Kelton, 3♂, 2♀ (CNC); Pingree Park, 3.ix.1972, L.A. Kelton, ex *Juniperus* sp., 1♂, 1♀ (CNC); Poudre Cyn, Mtn Park, 5.ix.1972, L.A. Kelton, ex *Picea* sp., 1♀ (CNC). *Las Animas Co.*: Cucharas Pass: 1 mi S of, 28.viii.1982, 9,000 ft, D.A. and J.T. Polhemus, *Picea* sp., 7♂, 5♀ (JTPC); Summit: side of, on Rt 12, 19.viii.1986, R.T. Schuh and J.T. Polhemus, ex *A. concolor* (AMNH): 9,200 ft, 4♂, 7♀; 9,900 ft, 6♂, 14♀; 9,300 ft, ex *Pinus aristata*,

1♂, 7♀. Monument Park, 28.viii.1982, 8,650 ft, D.A. and J.T. Polhemus, 2♂, 1♀ (JTPC); Stonewall, 18.viii.1986, R.T. Schuh (AMNH): ex *P. edulis*: 5 mi E of, 7,000 ft, 1♀; Fire Department, 1 mi E of town, 7,400 ft, 1♀ (AMNH). Purgatoire Cmpgrd Rd, 1 mi N of Stonewall, 8,400 ft, D.A. and J.T. Polhemus, ex *A. concolor*, 3♂, 8♀. Montrose Co.: Nucla, 27 mi E of, 9,200 ft, T.J. Henry, ex *Picea engelmanni*, 8♂, 1♀ (USNM); Silesca Ranger Station, Uncompahgre Plateau, 14.viii.1987, 9,000 ft, D.A. and J.T. Polhemus, 1♂, 2♀ (JTPC). Park Co.: Geneva Park, 6.ix.1982, 9,600 ft, D.A. and J.T. Polhemus, ex *P. flexilis*, 1♂, 6♀ (JTPC); Trout Crk Pass, Pike Nat. For., 28.viii.1968, L.A. Kelton, ex *P. aristata*, 2♂ (CNC). Pitkin Co.: Aspen, White River Nat. For., 24.viii.1968, L.A. Kelton, ex *Picea* sp., 1♀ (CNC); Avalanche, White River Nat. For., 23.viii.1968, L.A. Kelton, 1♂, 3♀ (CNC). Rio Blanco Co., South Fork Cmpgrd, 12 mi S of Buford, 6.viii.1978, J.T. Polhemus, 5♂, 11♀ (JTPC). Saguache Co.: 1 mi E of North Pass, 19.viii.1969, J.C. Schaffner, 5♂, 1♀ (TAM); 17 mi S of US 50 on Colo. 114, 31.viii.1980, D.A. and J.T. Polhemus, 1♂, 8♀ (JTPC). San Juan Co., Coal Bank Hill Summit, 1.8 mi N of, on Rt 550, San Juan Nat. For., 15.viii.1986, R.T. Schuh, 10,500 ft, ex *Pinus contorta*, 4♂, 1♀ (AMNH). Summit Co., Dillon, 29.viii.1972, L.A. Kelton, ex *Picea* sp., 8♂, 25♀ (CNC). **Montana:** Gallatin Co., Targhee Pass, Rt 191, 10.viii.1986, 7,002 ft, Schuh, Schwartz, Stonedahl, ex *A. lasiocarpa*, 15♂, 21♀ (AMNH). **New Mexico:** Los Alamos Co., Los Alamos, 15 mi W of, 23.viii.1972, L.A. Kelton, ex *Picea* sp., 2♂, 6♀ (CNC). Otero Co.: Cloudcroft: 23.viii.1967, L.A. Kelton, 1♂ (CNC); 7 mi N of, 13.viii.1982, J.C. Schaffner, ex *P. pungens*, 7♂, 9♀ (TAM). **Utah:** Carbon Co.: Old Folks Flat Cmpgrd on Rt 31, 14 mi NW of Huntington, T16S R7E, 8,000 ft, 8.viii.1981, M.D. Schwartz, ex *P. engelmanni*, 25♂, 54♀ (AMNH). Summit Co., Kamas, 20.2 mi E of, on Rt 150, 19.viii.1986, G.M. Stonedahl, ex *A. lasiocarpa*, *Pinus contorta*, 2♂, 1♀ (AMNH). Duchesne Co., Avintaquin Cmpgrd, 0.5 mi S of, on Rt 33, T11S R10E, 9.viii.1986, 9,000 ft, M.D. Schwartz, ex *Picea engelmanni*, 2♂, 4♀ (AMNH); Grandview Trailhead, Ashley Nat. For., Unita Mts, T3S R8W, Secs 17 & 19, 9,400 ft, 16.viii.1986, M.D. Schwartz and G.M. Stonedahl, ex *A. lasiocarpa*, 4♂, 7♀ (AMNH); Hades Cmpgrd Ashley Nat. For., Unita Mts, T3S R8W, Secs 17 & 19, 17.viii.1986, 7,400 ft, M.D. Schwartz and G.M. Stonedahl, ex *P. pungens*, 35♂, 79♀ (AMNH). Sanpete Co., Fairview, 13 mi E of, on Rt 31, T14S R6E, 7,500 ft, 8.viii.1981, M.D. Schwartz, ex *A. lasiocarpa*, 2♂, 2♀ (AMNH). Salt Lake Co., Snowbird Ski Resort, Little Cottonwood Cyn, Wasatch Mts. 19.ix.1986, 8,000 ft, M.D. Schwartz, ex *A. lasiocarpa*, *P. engelmanni*, 20♂, 44♀ (AMNH). Uintah Co.: same as holotype, 4♂, 5♀; Little Brush Crk nr, mp 22 on Rt 44, T1N R22E, Uinta Mtns, 8,620 ft, 2.viii.1981, M.D. Schwartz, ex *Pinus contorta*, 1♂ (AMNH). Wasatch Co., Lodgepole Cmpgrd nr Daniel Pass, UT40, T6S R6E, 7,800 ft, M.D. Schwartz, ex *Picea engelmanni* (AMNH): 2.ix.1981, 10♂, 52♀; 14.ix.1982, 21♂, 18♀.

Psallovirus flaviclavus (Knight)

Psallus flaviclavus Knight, 1930: 130 (n. sp.)

Psallovirus flaviclavus: Henry, 1999: 108 (n. comb.)

Diagnosis. This species is similar to *P. nigroantennatus* in length of antennal seg-

ment 2, which is shorter than the width of head across the eyes, but can be distinguished by the pale antenna.

Discussion. Previously only known from Estes Park, Colorado, the locality of the type series. The following new records provide new host associations (Mexican white pine, *Pinus strobiformis* Engelm. and *P. edulis*) and extend the distribution to southern Arizona.

Material examined. USA, **Arizona:** *Greenlee Co.:* FR 25, 0.5 mi NW of Hwy 191, 33°35'13"N 109°21'49"W, 9,160 ft, 19.viii.1998, J.C. Schaffner (TAM). *Pima Co.,* Santa Catalina Mts., Mt. Lemmon Radar Station, 9,000 ft, 29.ix.1988, M.D. Schwartz, ex *P. strobiformis* (AMNH). **Colorado:** *Larimer Co.,* 1 mi S of Poudre R on Pingree Park Rd, 37 mi W of Fort Collins, 6,900 ft, 14.vii.1986, R.T. Schuh, J.T. Polhemus, ex *Cercocarpus montanus* (AMNH). *Las Animas Co.:* Stonewall, 8,000 ft, 28.viii.1982, D.A. and J.T. Polhemus (JTPC); 1 mi N of Stonewall on Purgatoire Cmpgrd Rd, 8,400 ft, 18.viii.1986, R.T. Schuh, ex *P. ponderosa* (AMNH). *Montrose Co.,* Montrose, 13 mi SW of, 7,700 ft, T.J. Henry, ex *P. edulis* (USNM).

***Psallovirus nigroantennatus*, new species**

Figs. 16B, 17, 18B–E

Diagnosis. Distinguished by the black antenna, the second antennal segment much shorter than the width of the head across the eyes, the uniformly reddish brown to dark brown dorsum with the concolorous cuneal base, only extreme apex of emboliar margin and apex of the cuneus pale (Fig. 17), and the relatively large secondary gonopore of the vesica (Fig. 18B).

Description. Male (Figs. 16B, 17). Subparallel-sided, total length 2.9 (2.6–3.1), dorsum including cuneus brown, only cuneal base with thin translucent mark; extreme apices of emboliar margin and cuneus pale; vestiture with silky, silvery white scale-like setae and shining, brown simple setae; antenna and rostrum black; tibia dusky yellow. *Head:* including vertex brown to black, relatively wide; anteocular region and clypeus slightly produced; width 0.64 (0.60–0.65); vertex width 0.25 (0.24–0.26); eyes large, height of eye four-fifths of head height in lateral view; antennal socket level dorsal to ventral margin of eye, and slightly removed from anteroventral margin of eye; antennae dark brown to black; second antennal segment thickened distally; first segment short, exceeding apex of clypeus by one-quarter; antennal measurements 0.20 (0.19–0.21): 0.58 (0.54–0.60): 0.38 (0.35–0.40): 0.27 (0.23–0.29); rostrum dark brown, reaching apex of hind coxa, rostral length 1.13 (1.10–1.15). *Thorax:* mesoscutum, and scutellum dark brown, peritremal disk brown except anterior lobe pale. *Hemelytra:* black, base and apex of cuneus pale; membrane with obscure infusate areas, veins mostly pale, small areole with reddish brown veins. *Venter:* black. *Legs:* black, extreme apex of femora pale; tibia dusky yellowish brown, tibial spines black with black spots at bases. **Genitalia:** see Figs. 18B–E.

Female. Similar to male except: total length 2.5 (2.2–2.8); head width 0.64 (0.60–0.68); vertex width 0.31 (0.29–0.33); antennal measurements 0.20 (0.19–0.21): 0.49 (0.43–0.54): 0.36 (0.33–0.40): 0.29 (0.27–0.31); labium 1.13 (1.10–1.20).

Etymology. Named for the black antennae.

Discussion. Most similar to *P. flaviclavus* in size, distribution, and host preference, but is easily distinguished by the features mentioned in the diagnosis.

Hosts. Taken on yellow pine, *P. ponderosa*. In British Columbia also collected on Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco.

Distribution. Southern Okanagan Valley of British Columbia, south to Colorado, the Black Hills of South Dakota, and the northern Sierra Nevada Mountains of California.

Holotype. ♂, "USA, **Colorado**, Jefferson Co., Indian Hills, Falcon Pk., 7,200 feet August 21, 1986, coll: R.T. Schuh and J.T. Polhemus; ex *Pinus ponderosa* Laws. (Pinaceae)." Deposited in the American Museum of Natural History, New York.

Paratypes. CANADA, **British Columbia:** Geology Camp, 23.vii.1990, S.G. Cannings, ex mercury vapor lamp, 1♂, 1♀ (UBC); Hedley, 22.vii.1970, L.A. Kelton, ex douglas fir, 1♀ (CNC); Peniticton, 22.viii.1987, S.G. Cannings, 1♂ (UBC). USA, **Arizona:** Apache Co., 4.8 mi S of Hwy 60 on FR 117, 34°11'06"N 109°32'29"W, 7,930 ft, 19.viii.1998, J.C. Schaffner, 2♂, 1♀ (TAM). Pima Co., Mount Lemmon Santa Catalina Mtns 3.viii.1967, L.A. Kelton, ex *Pinus ponderosa*, 2♂, 1♀ (CNC). Cochise Co., Portal, 29.vii.1967, L.A. Kelton, ex *P. ponderosa*, 1♂, 1♀ (CNC). **California:** Plumas Co., Johnsville, 2.ix.1987, H. Pini, ex light trap, 2♂ (CAFA). **Colorado:** Las Animas Co., Cucharas Pass, 1 mi S of, 9,000 ft, 29.viii.1982, D.A. and J.T. Polhemus, 1♂ (JTPC). Jefferson Co.: Deer Crk Cyn, 6.viii.1987, D.A. and J.T. Polhemus, ex *Pseudotsuga menziesii*, 1♂, 2♀ (JTPC). Indian Hills: 12.viii.1986, D.A. Polhemus, 7,300 ft, ex *Pinus ponderosa*, 7♂, 13♀ (JTPC); same as holotype, 9♂, 12♀ (AMNH); 7,300 ft, 6.viii.1987, T.J. Henry, ex *P. ponderosa*, 4♂, 4♀ (USNM). El Paso Co., Monument, 9.viii.1977, 6,961 ft, J.T. Polhemus, 1♂ (JTPC). Larimer Co., Mtn Park Cmpgrd Roosevelt Nat. For., 8.viii.1968, 6,600 ft, L.A. Kelton, 3♀ (CNC). Douglas Co.: Perry Park, CL873, J.T. and D.A. Polhemus (JTPC): 27.vii.1977, 1♂, 1♀; 30.vii.1977, 1♀ (JTPC). Las Animas Co.: Stonewall: 28.viii.1982, J.T. and D.A. Polhemus, 2♂, 5♀ (JTPC); 3 mi N of, 8,100 ft, 18.viii.1986, R.T. Schuh and J.T. Polhemus, ex *P. ponderosa*, 3♂, 4♀ (AMNH). **Oregon:** Umatilla Co., 19 mi SE of Pendleton, Deadmans Pt. Rest Area on I-80 N, 20.viii.1979, M.D. Schwartz, ex *P. ponderosa*, 1♂, 1♀ (AMNH). **South Dakota:** Pennington Co., Pactola Lake, Black Hills, 5.viii.1971, L.A. Kelton, ex *P. ponderosa*, 16♂, 16♀ (CNC). **Utah:** Daggett Co., Dutch John, 9 mi S of, 0.2 mi N of jct 44 ♀ 260, T2N R22E, 2.viii.1981, 7,500 ft, M.D. Schwartz, ex *P. ponderosa*, 1♂ (AMNH). **Washington:** Asotin Co., Anatone 2.5 mi S of, 2 mi N of Rattlesnake Summit 4.viii.1986, 3,900 ft, Schuh, Schwartz, Stonedahl, ex *P. ponderosa*, 1♂, 6♀ (AMNH).

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LITERATURE CITED

- Fernald, M. L. 1950. Gray's Manual of Botany, 8th edition. American Book Co., New York, 1632 pp.
- Henry, T. J. 1999. The spider-commensal plant bug genus *Ranzovius* (Heteroptera: Miridae: Phylinae) revisited: Three new species and a revised key, with the description of a new sister genus and phylogenetic analysis. *Acta Soc. Zool. Bohemicae* 63:93–115.
- Henry, T. J. and A. G. Wheeler, Jr. 1988. Family Miridae Hahn, 1833. The plant bugs. Pp. 251–507 in T. J. Henry and R. C. Froeschner (eds.), *Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States*. E.J. Brill, Leiden, 958 pp.
- Kelton, L. A. 1972. Species of *Dichroscytus* found in Canada, with descriptions of four new species (Heteroptera: Miridae). *Can. Entomol.* 104:1033–1049.
- Kelton, L. A. 1977. Species of the genus *Pinalitus* Kelton found in North America (Heteroptera: Miridae). *Can. Entomol.* 109:1529–1554.
- Kelton, L. A. and H. H. Knight. 1970. Revision of the genus *Platylygus*, with descriptions of 26 new species (Hemiptera: Miridae). *Can. Entomol.* 103:1429–1460.
- Kerzhner, I. M. 1997. Notes on taxonomy and nomenclature of Palaearctic Miridae (Heteroptera). *Zoosyst. Ross.* 5:245–248.
- Knight, H. H. 1927. Descriptions of twelve new species of Miridae from the District of Columbia and vicinity (Hemiptera). *Proc. Biol. Soc. Washington* 40:9–18.
- Knight, H. H. 1964. *Phymatopsallus* new genus, and new species of Phylinae from North America (Hemiptera, Miridae). *Ia. St. J. Sci.* 38:127–152.
- Munz, P. A. and D. D. Keck. 1970. *A California Flora*. Univ. Calif., Berkeley, 1681 pp.
- Polhemus, D. A. 1994. An annotated checklist of the plant bugs of Colorado (Heteroptera: Miridae). *Pan.-Pac. Entomol.* 70:122–147.
- Stonedahl, G. M. 1990. Revision and cladistic analysis of the Holarctic genus *Atractotomus* Fieber (Heteroptera: Miridae: Phylinae). *Bull. Am. Mus. Nat. Hist.* 198:88 pp.
- Stonedahl G. M. and M. D. Schwartz. 1996. Two new genera for pine-inhabiting species of Phylini in North America (Heteroptera: Miridae: Phylinae). *Am. Mus. Novitates* No. 3166:15 pp.
- Wheeler, A. G., Jr., T. J. Henry and T. L. Mason, Jr. 1983. An annotated list of the Miridae of West Virginia (Hemiptera-Heteroptera). *Trans. Am. Entomol. Soc.* 109:127–159.

**PHOENICOCORIS CLARICORNIS AND PINOPHYLUS CARNEOLUS
(HEMIPTERA: MIRIDAE): DISTRIBUTION AND SEASONALITY
OF TWO SPECIALISTS ON MICROSPORANGIATE STROBILI
OF PINES**

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Abstract.—The phyline mirids *Phoenicocoris claricornis* (Knight) and *Pinophylus carneolus* (Knight) are seldom collected because of their early-season, univoltine life cycles. Surveys were conducted in the eastern United States to delimit their distributions and to determine host-plant relationships. The seasonal history of both plant bugs was studied in southcentral Pennsylvania on Virginia pine (*Pinus virginiana*) during 1976–1977. Known previously from New Jersey and West Virginia, *Phoenicocoris claricornis* is newly recorded from Alabama, Georgia, Kentucky, Maine, Maryland, New Hampshire, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, and Virginia. New state records for *Pinophylus carneolus*, previously recorded from Maryland, Pennsylvania, Virginia, West Virginia, and Wisconsin, are Alabama, Florida, Georgia, Kentucky, New York, North Carolina, Ohio, South Carolina, and Tennessee. Both mirids develop on the staminate strobili of pines, mainly Virginia pine in the mid- and southern Appalachians and pitch pine (*Pinus rigida*) in the Northeast. Sand pine (*Pinus clausa*) is a host of *Pinophylus carneolus* in northwestern Florida. In southcentral Pennsylvania, overwintered eggs of *Pinophylus carneolus* hatch in early April, and adults appear by early May and are present only until mid- to late-May. The seasonality of *Phoenicocoris claricornis* is similar, its populations developing about a week later than those of *Pinophylus carneolus*.

North American conifers, especially pines (*Pinus* spp.), support a rich mirid fauna. In reporting braconid parasitism of Miridae occurring on lodgepole pine (*P. contorta* Loudon) in Oregon and Wyoming, Lattin and Stanton (1999) remarked that about 50 mirid species are associated with this tree throughout its range in western North America. Even so, mirid diversity of North American conifers and bionomics of the individual species mostly remain undocumented. Exceptions are studies of plant bugs on noble fir (*Abies procera* Rehd.) in the western United States (Cooper 1981) and on arbovitae (*Thuja*), false cypress (*Chamaecyparis*), and juniper (*Juniperus*) in the East (Wheeler and Henry, 1977). The latter paper summarized the scant literature on Miridae of North American conifers.

In the eastern United States, the diverse plant bug fauna of pines, mainly pitch pine (*P. rigida* Mill.) and Virginia (or scrub) pine (*P. virginiana* Mill.), includes two phyline mirids that specialize on the microsporangiate strobili, sometimes referred to as “male” or “pollen” cones or as “catkins.” Here I review the previously recorded distributions and hosts of *Phoenicocoris claricornis* (Knight) and *Pinophylus carneolus* (Knight), add new state and host-plant records, and discuss the seasonality, habits, and host relationships of the two species. For a diagnosis and re-description, and illustrations of the adult habitus and male genitalia of *Pinophylus carneolus*, readers should refer to Schwartz and Schuh (1999, this issue); in that

paper, they transfer *carneolus*, previously placed in *Plagiognathus* Fieber, to their new genus *Pinophylus*.

This paper is dedicated to my colleague and friend John T. Polhemus, a heteropterist of international reputation. Although he is renowned for his taxonomic studies on aquatic and semiaquatic Heteroptera, he has (with his son Dan) also described new taxa of Miridae. May his exceptional research productivity continue to flourish.

MATERIALS AND METHODS

Collecting techniques and surveys. During 1975–1999, distributional and host-plant data on *Phoenicocoris claricornis* and *Pinophylus carneolus* were obtained by sampling pitch pine and Virginia pine nearly throughout the ranges of both plant species. Pitch pine was sampled mostly in New England, New York, and the mid-Appalachians, whereas Virginia pine was sampled from Pennsylvania to northern Georgia and northeastern Alabama. *Phoenicocoris claricornis* and *Pinophylus carneolus* were collected by the limb-tap method described by Wheeler (1991) for Miridae of scrub oak (*Quercus ilicifolia* Wengen.). When collections consisted only of late-instar nymphs, adults were obtained by caging nymphs on host twigs bearing male strobili.

New state records are indicated by an asterisk under Distribution; for information on hosts, see Host plants under each species. A parenthetical “N” (N) indicates a collection consisting only of nymphs (see also Seasonal history and habits of both mirids). The numbers of adult males and females collected are given mostly for 1999 surveys. Voucher specimens have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., and the Pennsylvania Department of Agriculture, Harrisburg.

Seasonal history and habits. Seasonality of both mirid species was studied on Virginia pine in the Valley and Ridge Province of Pennsylvania at a site 16 km NNE. of Harrisburg in West Hanover Township, Dauphin County. The site was about 2 km NNW. of Pickettown (N40°23.6', W76°46.2'; elev. 180 m). Mirids were sampled at least weekly or biweekly from early April until early or mid-June—that is, until neither univoltine, early-season species could be detected; trees thus were sampled twice after neither species was present in samples. Sample dates in 1976 were 8, 11, 17 and 30 April; 5, 14, and 22 May; and 1 and 9 June. In 1977, mirids were sampled on 3, 10, 18, 24, and 27 April; 1, 3, 8, 15, and 23 May; and 5 and 12 June. On each date, all individuals of *Phoenicocoris claricornis* and *Pinophylus carneolus* (usually <10 of both species) beaten from Virginia pines during 30–45 minutes were identified to stage in the field and the numbers of each stage recorded; early instars were sorted to stage in the laboratory.

Additional information on seasonal history of these plant bugs in Pennsylvania was obtained by sampling Virginia pine five times at Paxinos, Northumberland County, during April and May 1975–1977. Supplemental data on seasonality were obtained in 1999 during surveys to determine the bugs' distributions, mainly in the mid- and southern Appalachians. Virginia pine was sampled in Alabama, Georgia, Kentucky, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and West Virginia. Pitch pine and table mountain pine (*P. pungens* Lamb.) were also sampled in the Appalachians where they co-occurred with Virginia pine.

In the field, nymphs of *Phoenicocoris claricornis* and *Pinophylus carneolus* oc-

curred consistently on male strobili of Virginia pine; their feeding behavior, however, was difficult to observe. To verify their suspected feeding on male reproductive structures of their hosts, early and late instars were placed on excised terminals of Virginia pine in plastic boxes (ca. 22°C) and their behavior observed under a binocular microscope.

The oviposition sites of *Pinophylus carneolus* were determined by cutting terminal shoots from Virginia pine in late March, holding the shoots in the laboratory at ca. 21°C and 35% RH, and examining them daily for the presence of first instars. Once neonates of the mirid were detected, egg shells marking sites of oviposition could be located.

Phoenicocoris claricornis (Knight)

Distribution. Described in *Lepidopsallus* Knight by Knight (1923) (and transferred to *Phoenicocoris* Reuter by Stonedahl [1990]) from a female collected on 29 May (no year given) at Lakehurst, N.J., *Phoenicocoris claricornis* has since been reported only from West Virginia (Wheeler et al. 1983). The following additional records were obtained during the present study.

***Alabama:** Dekalb Co., Rt. 117, 1 km W. of Hammondville (2♂) & Sulphur Springs, 22 Apr. 1999 (2♂, 1♀). ***Georgia:** Murray Co., Rt. 76, NW. of Chatsworth, 22 Apr. 1999 (1♀). ***Kentucky:** McCreary Co., Stearns, 24 Apr. 1999 (N); Madison Co., Rt. 21, Berea, 24 Apr. 1999 (N) & 2 May 1999 (1♀); Nelson Co., Rt. 62, 2.6 km E. of Boston, 2 May 1999 (3♂). ***Maine:** Oxford Co., Rt. 113, S. of Fryeburg, 19 June 1993; York Co., Rt. 95, 1.7 km SE. of West Kennebunk, 19 June 1993. ***Maryland:** Prince George's Co., Beltsville, 4 May 1986; Washington Co., Rt. 40, 3.2 km E. of Rt. 56 E. of Indian Springs, 3 May 1982 (N). ***New Hampshire:** Merrimack Co., Concord, 19 June 1993. ***New York:** Albany Co., Albany, 4 June 1994; Clinton Co., Rt. 87 exit 36, 5.4 km SW. of Plattsburgh, 12 June 1993 & 5 June 1994 (N); Saratoga Co., County Airport, 5.6 km NNW. of Ballston Spa, 12 June 1993 & 4 June 1994; Warren Co., Queensbury, 12 June 1993 & 4 June 1994. ***North Carolina:** Buncombe Co., Rts. 19–23, 2.5 km NNW. of Weaverville, 3 May 1999 (N); Gaston Co., Crowder Mountain State Park, 22 Apr. 1988; Guilford Co., Rt. 68, nr Oak Ridge, 11 Apr. 1982 (N); Jackson Co., Sylva, 25 Apr. 1999 (N); Rockingham Co., Rt. 220 nr Madison, 11 May 1978 & Reidsville, 11 May 1987. ***Ohio:** Athens Co., Rts. 7–50, 3.5 km NE. of Coolville, 1 May 1999 (N); Monroe Co., T-565, SE. of Marr, 29 May 1994. ***Pennsylvania:** Dauphin Co., numerous collections at main sample site (see Materials and Methods for dates); Lancaster Co., Mason Dixon Rd., S. of Wakefield, 25 May 1978 (N); Lebanon Co., Rt. 443, 4.8 km S. of Suedburg, 10 May 1977 (N); Luzerne Co., Nanticoke, 5 May 1977 (N); Montour Co., jct. Rts. 45 & 642, 1.7 km W. of Mooresburg, 10 May 1977 (N); Northumberland Co., Rt. 901 S. of Ranshaw, 10 May 1977 (N) & Paxinos (several collections, April–May 1975–1977); Perry Co., Rt. 322, 3.2 km E. of Newport exit, 21 Apr. 1977 (N); Union Co., Rt. 15, White Deer, 21 Apr. 1977 (N). ***South Carolina:** Greenville Co., Caesars Head State Park, Pinnacle Falls, 16 Apr. 1997 (N); Pickens Co., Boggs Rock, 1.6 km N. of Liberty, 23 Apr. 1988 & Glassy Mountain Heritage Preserve, 4.8 km NE. of Pickens, 3 May 1996. ***Tennessee:** Campbell Co., Caryville, 3 May 1999 (1♂); Knox Co., Rt. 75 exit 110, 2.7 km SE. of Powell, 23 Apr. 1999 (N); McMinn

Co., Athens, 22 Apr. 1999 (1♀). ***Virginia:** Alleghany Co., Rt. 64, 2 km E. of Callaghan, 9 May 1999 (1♀); Bath Co., Rt. 703, Bald Knob, 28 May 1993 (N); Bland Co., Walker Mountain, Rt. 717, 0.3 km N. of Wythe Co. line SSE. of Bland, 8 May 1999 (1♀); Botetourt Co., Eagle Rock, 8 May 1999 (2♂, 6♀) & Rt. 81 Rest Area, 2.4 km N. of jct. Rt. 640, SE. of Fincastle, 11 May 1978, 10 May 1979, 24 Apr. 1981 (N), 8 May 1987 (N); Buckingham Co., Rt. 15, 4 km NNE. of Dillwyn, 24 Apr. 1981 (N); Montgomery Co., Rt. 460, 7 km N. of Blacksburg, 8 May 1999 (N).

Host plants. Recorded from Virginia pine in West Virginia (Wheeler et al. 1983), *Phoenicocoris claricornis* was found mostly on this host plant during my surveys. *Pinus virginiana* was the host for collections in Ohio and Pennsylvania south to Alabama and Georgia, except for three collections from *P. rigida*. At the main study site in Dauphin Co., Pennsylvania, a fourth instar was beaten (1 May 1977) from a mature pitch pine within 50 m of the stand of Virginia pine used for weekly or biweekly sampling. Two early instars were found on pitch pine at White Deer, Union Co., Pennsylvania, on 21 April 1977. A late instar was beaten (28 May 1993) from an extensive stand of stunted pitch pine on Bald Knob, Bath Co., Virginia. At the few sites in the mid-Appalachians where Virginia and pitch pine were both common—for example, Walker Mountain in Bland Co., Virginia—*Phoenicocoris claricornis* was found only on *Pinus virginiana*.

North of the range of Virginia pine, however, pitch pine was the only host on which *Phoenicocoris claricornis* was found. Collections from Maine, New Hampshire, and New York were all from *Pinus rigida*.

Seasonal history and habits. At the main study site in southcentral Pennsylvania, overwintered eggs of *Phoenicocoris claricornis* hatched from early to mid-April. By late April, populations consisted of fourth- and fifth-instar nymphs in 1976 and 1977. Adults only were observed on 14 May 1976, the 5 May sample consisting solely of late instars (3 IVs, 15 Vs). Adults, still present on 22 May, were not encountered during sampling on 1 and 9 June. In 1977, fourth and fifth instars were collected on 1 and 3 May; by 8 May, a few adults (N = 3) were present with larger numbers of fifth instars (N = 14). Adults outnumbered fifth instars on 15 May (8:3), adults were present on 23 May, but they were not seen during sampling on 5 and 12 June. A generalized seasonality of *Phoenicocoris claricornis* in southcentral Pennsylvania is shown in Fig. 1.

Less frequent sampling at Paxinos, Northumberland Co., Pennsylvania, indicated a similar seasonality. Fifth instars were found on 4 May 1976 and fifth instars and a smaller number of adults on 10 May 1977; in 1975, fifth instars were observed on 21 May and only adults a week later. In Botetourt Co., Virginia, adults and a fifth instar were found on 11 May 1978 and adults on 10 May 1979. New York and New England populations developed about a month later than those in central Pennsylvania; late instars and adults were observed in early June and adults in mid-June.

A population in eastern Ohio consisted of fourth and fifth instars on 1 May 1999. In Kentucky and Tennessee, late instars (mostly Vs) were observed with a few teneral adults during 23–24 April. On 22 April, adults were found in northeastern Alabama and Georgia; the few remaining nymphs were parasitized by a euphorine braconid. At higher elevations in western North Carolina (>600 m), fifth instars were observed on 25 April and 3 May.

Nymphs of *Phoenicocoris claricornis* develop on the clustered, catkin-like staminate strobili that form at the base of current-season growth of Virginia and other host pines. Male strobili of Virginia pine are 10–20 mm long (Flora of North America Editorial Committee 1993). Early instars feed from the outside of Virginia pine's red-brown or yellow microsporangiate strobili, presumably obtaining nutrition from the microsporangia (pollen sacs) and their developing pollen grains. Pollen dissemination in *Pinus virginiana* usually begins during late April to early May in south-central Pennsylvania (Fig. 1) where this mirid's seasonal history was studied. Once the microsporophylls separate at anthesis, the nymphs, by then mostly late instars, also feed within the strobili.

Pinophylus carneolus (Knight)

Distribution. Knight (1927) described this plant bug (in *Plagiognathus*) from Maryland and Virginia. Subsequent records are Pennsylvania, West Virginia, and Wisconsin (Henry and Wheeler, 1988). The listing of *Pinophylus carneolus* (as *Plagiognathus carneolus*) from the District of Columbia (Henry and Wheeler, 1988) likely represents a misreading of Knight and McAtee's (1929) paper on Miridae of the District of Columbia and vicinity, which included only the Maryland and Virginia records noted in the original description. Both localities mentioned by Knight (1927)—Odenton, Md., and Falls Church, Va.—are near Washington, D.C. The following records extend the known distribution of *Pinophylus carneolus*.

***Alabama:** Dekalb Co., Rt. 117, 1 km W. of Hammondville, 22 Apr. 1999 (1♀); Jackson Co., sandstone outcrop, Flatrock, 10 Apr. 1997 (1♀). ***Florida:** Walton Co., Sandestin Blvd., 16 km E. of Destin between Rt. 98 and Horseshoe Bayou, 1–2 Mar. 1999 (1♂, 3♀). ***Georgia:** Chattooga Co., Rt. 48, 2 km E. of Menlo, 22 Apr. 1999 (3♀); Rabun Co., Clayton, 22 Apr. 1999 (2♀); Towns Co., Hiawassee, 22 Apr. 1999 (N). ***Kentucky:** Laurel Co., London, 23 Apr. 1999 (N); McCreary Co., Stearns, 24 Apr. 1999 (N); Madison Co., Rt. 21, Berea, 24 Apr. 1999 (N); Nelson Co., Rt. 62, 2.6 km E. of Boston, 2 May 1999 (1♂); Whitley Co., Corbin, 3 May 1999 (1♂, 2♀). ***Maryland:** Prince George's Co., Beltsville, 7 May 1986; Washington Co., Rt. 40, 3.2 km W. of Rt. 56, NW. of Big Pool, 13 May 1982 (1♀). ***New York:** Albany Co., Albany, 4 June 1994; Saratoga Co., County Airport, 5.6 km NNW. of Ballston Spa, 4 June 1994; Warren Co., Queensbury, 4 June 1994. ***North Carolina:** Buncombe Co., Rts. 19–23, 2.5 km NNW. of Weaverville, 3 May 1999 (2♂, 4♀); Clay Co., Hayesville, 22 Apr. 1999 (N); Gaston Co., Crowder Mountain State Park, 22 Apr. 1988; Guilford Co., Rt. 68 nr Oak Ridge, 11 Apr. 1982 (N); Jackson Co., Sylva, 25 Apr. 1999 (1♂); Rockingham Co., Rt. 220, 5.6 km S. of Virginia state line nr Stoneville, 9 Apr. 1979 (N), 13 May 1979 & 6 Apr. 1980 (N); Swain Co., Cherokee, 25 Apr. 1999 (1♂). ***Ohio:** Athens Co., Rts. 7–50, 3.5 km NE. of Coolville, 1 May 1999 (1♂); Gallia Co., Rt. 160, 5 km NW. of Gallipolis, 1 May 1999 (N); Monroe Co., Rt. 260, 8 km S. of Marr, 1 May 1999 (N); Washington Co., Little Hocking, 1 May 1999 (N). ***Pennsylvania:** Cumberland Co., nr Newburg, 5 May 1973 (N); Dauphin Co., numerous collections at main sample site (see Materials and Methods for dates); Franklin Co., Orbisonia, 17 Apr. 1974 (N); Fulton Co., Licking Cr. Twp. NW. of McConnellsburg, 11 May 1983 (N); Huntingdon Co., 6.4 km S. of Orbisonia, 15 May 1973 (1♂, 2♀); Lancaster Co., Mason Dixon Rd., S. of Wakefield, 25 May

1978 (1 ♀); Montour Co., jct. Rts. 45 & 642, 1.7 km W. of Mooresburg, 10 May 1977 (1 ♀); Northumberland Co., Rt. 901 S. of Ranshaw, 10 May 1977 & Paxinos (several collections, April–May 1975–1977); Washington Co., Rt. 519 nr Houston, 21 May 1973. ***South Carolina:** Lancaster Co., Rt. 200, S. of Lancaster, 9 Apr. 1988 (N) & Springs Park, 8 km N. of Great Falls, 9 Apr. 1988; Pickens Co., Boggs Rock, 1.6 km N. of Liberty, 23 Apr. 1988. ***Tennessee:** Campbell Co., Caryville, 3 May 1999 (1 ♂, 2 ♀); Knox Co., Rt. 75 exit 110, 2.7 km SE. of Powell, 23 Apr. 1999 (2 ♀); Morgan Co., Sunbright, 24 Apr. 1999 (N); Scott Co., Rt. 27, Helenwood, 24 Apr. 1999 (1 ♂). **Virginia:** Alleghany Co., Rt. 64, 4.8 km NNE. of Jerrys Run, 9 May 1999 (N); Bath Co., Rt. 703, 2 km S. of Bald Knob, 9 May 1999 (N); Bland Co., Walker Mountain, Rt. 717, 0.3 km N. of Wythe Co. line SSE. of Bland, 30 Apr. (N) & 8 May 1999 (12 ♂, 8 ♀); Botetourt Co., Eagle Rock, 8 May 1999 (2 ♂, 6 ♀) & Rt. 81 Rest Area, 2.4 km N. of Rt. 640 SE. of Fincastle, 11 May 1978 (1 ♀) & 13 Apr. 1984 (N); Buckingham Co., Rt. 15, 4 km NNE. of Dillwyn, 24 Apr. 1981 (2 ♂, 1 ♀); Montgomery Co., Rt. 460, 7 km N. of Blacksburg, 8 May 1999 (1 ♀). **West Virginia:** Greenbrier Co., Rt. 64, Alta, 9 May 1999 (3 ♂, 1 ♀); Wood Co., Rt. 14, 2 km N. of Mineral Wells, 30 Apr. 1999 (N).

Host plants. Knight (1927) based his description of *Pinophylus carneolus* on specimens W. L. McAtee found “breeding” on *Pinus virginiana*. Virginia pine also is the host recorded for this plant bug in West Virginia (Wheeler et al., 1983). In Wisconsin, Rauf et al. (1985) observed feeding by *Pinophylus carneolus* on staminate strobili of jack pine (*Pinus banksiana* Lamb.). Similar habits on jack pine were reported for another phylina mirid, *Microphylellus nigricornis* Knight (a synonym of *M. flavipes* [Provancher]), but the observations of Rauf et al. (1985) were based on a misidentification of *Pinophylus carneolus* males (T. J. Henry, pers. comm.). Males of this sexually dimorphic species are more slender and typically are darker than the yellowish-brown females. Knight (1927) described the male as pale to yellowish brown, but some males in his type series might have been teneral.

Host relationships are similar to those of *Phoenicocoris claricornis*. My collections from Pennsylvania to the southern Appalachians were all from Virginia pine. Unlike *Phoenicocoris claricornis*, *Pinophylus carneolus* was not collected in that region on pitch pine. But northern populations (New York), like those of *Phoenicocoris claricornis*, were found only on pitch pine. Northern populations apparently also develop on jack pine, at least in Wisconsin (Rauf et al., 1985).

In northwest Florida, I collected *Pinophylus carneolus* on sand pine (*Pinus clausa* [Chapm. ex Engelm.] Vasey ex Sarg.), a conifer restricted to Florida and extreme southern Alabama. Populations of this pine in the Florida panhandle, which are disjunct from those of peninsular Florida, belong to the geographic race Choctaw-hatchee (var. *immuginata* D. B. Ward) (Brendemuehl, 1990). Closely related to Virginia pine in subsection *Contortae* of the genus *Pinus* (Parker et al., 1997), *P. clausa* can be artificially hybridized with *P. virginiana* (Brendemuehl, 1990).

Seasonal history and habits. The seasonal history of *Pinophylus carneolus* is similar to that of *Phoenicocoris claricornis*, the hatching of overwintered eggs and appearance of adults occurring about a week earlier (Fig. 1). At the main study site in Pennsylvania, first instars were observed on 11 April in 1976 (none were seen on 8 April) and were first found on 3 April in 1977. The 30 April sample consisted only of fifth instars (N = 11) in 1976; adults (N = 3) and a fifth instar were found

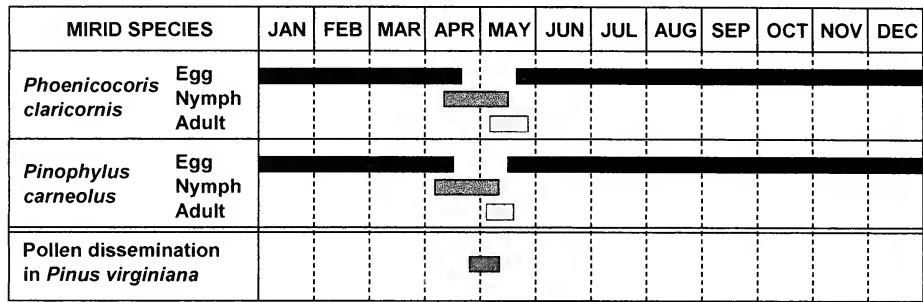


Fig. 1. Generalized seasonality in southcentral Pennsylvania of the mirids *Phoenicocoris claricornis* and *Pinophylus carneolus*, which specialize on the microsporangiate strobili of pines. Also shown is the approximate period of pollen dissemination in Virginia pine at the main study site.

on 5 May. In 1977, fourth (N = 2) and fifth instars (N = 10) were present on 24 April; fifth instars on 27 April; and one fourth instar, two fifth instars, and four teneral adults on 1 May. Adults were still present (N = 1) on 14 May 1976, but they were not observed in the 22 May or 1 June samples. In 1977, adults were found (N = 2) on 15 May but were not collected during sampling on 23 May or 5 June.

As in *Phoenicocoris claricornis*, fifth instars and mostly teneral adults were found in the southern Appalachians during late April and in Kentucky and Ohio in early May. Adults were collected in early March in northwestern Florida. In northern New York, fifth instars and adults were found in early June. There is thus at least a three-month difference between the appearance of adults in southern versus northern populations of this univoltine plant bug.

Eggs of *Pinophylus carneolus* were inserted at the bases of needles within 2–3 mm of the developing staminate strobili. Nymphs, like those of *Phoenicocoris claricornis*, feed on the microsporangiate strobili of host pines. The tan or yellowish-brown nymphs are well camouflaged on host strobili. Nymphs and adults were not found on small, nonreproductive trees and were consistently most numerous on heavily flowering trees.

DISCUSSION

Nymphs of the phyline mirids *Phoenicocoris claricornis* and *Pinophylus carneolus*, as specialists on male reproductive structures of Virginia and certain other pines, occur consistently on host branches that bear microsporangiate strobili. Like nearly all other pines, *Pinus virginiana* is monoecious, the male and female strobili borne separately on the same tree (Carter and Snow, 1990). Male strobili of many pines are more numerous in the lower crown (Burns and Honkala, 1990). Nymphs of both mirids were found only on trees that had attained a permanent reproductive stage. The minimum age of staminate “flower” production in Virginia pine is about eight years (Righter, 1939).

In southcentral Pennsylvania, adults of *Phoenicocoris claricornis* and *Pinophylus carneolus* appear by early May and die within two or three weeks. Among the Miridae associated with Virginia pine at the main study site (>20 species; A. G.

Wheeler, unpubl. data), these univoltine phylines are the first to develop. Their early-season occurrence largely explains the scarcity of specimens in collections and the lack of literature on their bionomics.

The known ranges of both mirid species are similar. *Phoenicocoris claricornis* was found from central Maine to northeastern Alabama and *Pinophylus carneolus* from northern New York to northwestern Florida. The western limits of their ranges are inadequately known. In the present study, *Phoenicocoris claricornis* and *Pinophylus carneolus* were found as far west as central Kentucky and Tennessee; the latter species, however, has been reported from as far west as Wisconsin (Rauf et al., 1985). Known altitudinal ranges of these mirids are also similar: from near sea level in both species, with *Phoenicocoris claricornis* ranging to about 1,250 m above sea level and *Pinophylus carneolus* to about 1,170 m.

Both mirids are common on Virginia pine, which occurs from northeastern Mississippi north to Long Island, New York (Carter and Snow, 1990). North of Long Island, pitch pine is the only known host in the Northeast. Where pitch pine co-occurs with Virginia pine in the mid- and southern Appalachians, *Phoenicocoris claricornis* was found occasionally on pitch pine, but *Pinophylus carneolus* was collected only on Virginia pine. Neither species was observed to develop on table mountain pine. Additional field work in the Appalachians is needed to clarify host relationships of both plant bugs in that region. *Pinophylus carneolus*, which occurs on jack pine in Wisconsin (Rauf et al., 1985), should be searched for on this conifer in northern New York and in New England. Sand pine, a host of *Pinophylus carneolus* in the Florida panhandle, might also serve as a host plant in peninsular Florida, although northwestern Florida could represent the southern extent of this plant bug's range.

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LITERATURE CITED

- Brendemuehl, R. H. 1990. *Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg. Sand pine. pp. 294-301 in R. M. Burns and B. H. Honkala (tech. coords.), *Silvics of North America*, Vol. 1. Conifers. U.S. Dep. Agric. For. Serv. Agric. Handb. 654.
- Burns, R. M. and B. H. Honkala, tech. coords. 1990. *Silvics of North America*, Vol. 1. Conifers, U.S. Dep. Agric. For. Serv. Agric. Handb. 654:675 pp.

- Carter, K. K. and A. G. Snow, Jr. 1990. *Pinus virginiana* Mill. Virginia pine. Pp. 513-519 in R. M. Burns and B. H. Honkala (tech. coords.), *Silvics of North America*, Vol. 1. Conifers. U.S. Dep. Agric. For. Serv. Agric. Handb. 654.
- Cooper, G. M. 1981. The Miridae (Hemiptera: Heteroptera) associated with noble fir, *Abies procera* Rehd. M.S. thesis, Oregon State University, Corvallis, 135 pp.
- Flora of North America Editorial Committee. 1993. *Flora of North America North of Mexico*, Vol. 2. Pteridophytes and Gymnosperms. Oxford University Press, New York, 475 pp.
- Henry, T. J. and A. G. Wheeler, Jr. 1988. Family Miridae Hahn, 1833 (=Capsidae Burmeister, 1835). The plant bugs. Pp. 251-507 in T. J. Henry and R. C. Froeschner (eds.), *Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States*. E. J. Brill, Leiden.
- Knight, H. H. 1923. Family Miridae (Capsidae). Pp. 422-658 in W. E. Britton (ed.), *Guide to the Insects of Connecticut*. Part IV. The Hemiptera or Sucking Insects of Connecticut. Conn. Geol. Nat. Hist. Surv. Bull. 34.
- Knight, H. H. 1927. Descriptions of twelve new species of Miridae from the District of Columbia and vicinity (Hemiptera). *Proc. Biol. Soc. Wash.* 40:9-18.
- Knight, H. H. and W. L. McAtee. 1929. Bugs of the family Miridae of the District of Columbia and vicinity. *Proc. U.S. Natl. Mus.* 75(13):1-27.
- Lattin, J. D. and N. L. Stanton. 1999. Host records of Braconidae (Hymenoptera) occurring in Miridae (Hemiptera: Heteroptera) found on lodgepole pine (*Pinus contorta*) and associated conifers. *Pan-Pac. Entomol.* 75:23-31.
- Parker, K. C., J. L. Hamrick, A. J. Parker and E. A. Stacy. 1997. Allozyme diversity in *Pinus virginiana* (Pinaceae): intraspecific and interspecific comparisons. *Am. J. Bot.* 84:1372-1382.
- Rauf, A., D. M. Benjamin and R. A. Cecich. 1985. Insects affecting seed production of jack pine, and life tables of conelet and cone mortality in Wisconsin. *For. Sci.* 31:271-281.
- Righter, F. I. 1939. Early flower production among the pines. *J. For.* 37:935-938.
- Schwartz, M. D. and R. T. Schuh. 1999. New genera and species of conifer-inhabiting phylinae plant bugs from North America (Heteroptera: Miridae). *J. New York Entomol. Soc.* (in press).
- Stonedahl, G. M. 1990. Revision and cladistic analysis of the Holarctic genus *Atractotomus* Fieber (Heteroptera: Miridae: Phylinae). *Bull. Am. Mus. Nat. Hist.* 198:1-88.
- Wheeler, A. G., Jr. 1991. Plant bugs of *Quercus ilicifolia*: myriads of mirids (Heteroptera) in pitch pine-scrub oak barrens. *J. New York Entomol. Soc.* 99:405-440.
- Wheeler, A. G., Jr. and T. J. Henry. 1977. Miridae associated with Pennsylvania conifers. 1. Species on arborvitae, false cypress, and juniper. *Trans. Am. Entomol. Soc.* 103:623-656.
- Wheeler, A. G., Jr., T. J. Henry and T. L. Mason, Jr. 1983. An annotated list of the Miridae of West Virginia (Hemiptera-Heteroptera). *Trans. Am. Entomol. Soc.* 109:127-159.

ONE NEW GENUS AND THREE NEW SPECIES OF ACANTHOCEPHALINI (HEMIPTERA: HETEROPTERA: COREIDAE: COREINAE)

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Abstract.—*Cleotopetalops* new genus, and three new species, *C. bicolor*, *C. cyanocephalus*, and *C. polhemi*, collected in Ecuador and Peru, are described, illustrated, and included in the tribe Acanthocephalini (Coreidae). Each species is compared with the closest one.

The Acanthocephalini is a New World tribe with its greatest diversity in the tropics. Some species exhibit an attractive green or blue iridescence, although coloration throughout the tribe varies widely. It is abundant and diverse not only in the number and variety of taxa present, but in the abundance of many individuals of some species.

The tribe can be recognized by the tylus projecting conspicuously beyond the juga as a distinct acute plate, the juga deflexed, the abdominal spiracles close to the anterior edge of the sternum, hind femora of males usually greatly incrassate, and all femora of both sexes ventrally armed (Packauskas, 1994).

Brailovsky (1997) listed the known genera of Acanthocephalini, described one new genus and two new species from Peru, and discussed the differences between this tribe and Anisoscelini.

This article adds one new genus and three new species, collected in Ecuador and Peru. This new genus is apparently unique among members of Acanthocephalini in having the humeral angles remarkably produced into sharp spines turning upward and slightly backwards, the metapleural supracoxal spine lacking in both sexes, the male hind femora not greatly incrassate, the hind tibiae cylindrical and not expanded, antennal segment III cylindrical, and the pronotum with distinct collar.

The following abbreviations are used in the text: California Academy of Sciences, San Francisco (CAS); Joe E. Eger collection (EGER); Pontificia Universidad Católica del Ecuador (PUCE); Instituto de Biología, Universidad Nacional Autónoma de México (UNAM); United States National Museum, Smithsonian Institution, Washington D.C. (USNM).

All measurements are in millimeters.

Cleotopetalops, new genus

Description. *Head.* Wider than long, quadrate, non declivent, flat dorsally; tylus acute, incrassate medially, projecting beyond antenniferous tubercles by less than half length, and scarcely raised above dorsal level of antenniferous tubercles; juga not visible from above, not extending past antenniferous tubercles; antenniferous tubercles parallel, unarmed, closely appressed to tylus; posttylar depression with single sulcus; antennal segment I stouter than segments II to IV, longer than maximal

length of head, and scarcely curved outwards; segments II and III cylindrical, slender, and segment IV fusiform; antennal segment IV the longest, segment III the shortest, and I longer than II; antennal segment IV longer than II and III combined; ocelli conspicuously tuberculate; preocellar pit subcircular, and deep; eyes hemispherical, protuberant; postocular tubercle nearly smooth with eye, indistinct; buccula semicircular, short, elevated, not projecting beyond anterior margin of eye; rostrum reaching posterior border of mesosternum, or anterior margin of metasternum; proportion between the length of each rostral segment variable through the species. *Pronotum*. Wider than long, trapeziform, declivous, with distinct collar; frontal angles blunt; anterolateral margins obliquely straight, nodulose; humeral angles remarkably produced into sharp spines, turning upward, and slightly backwards; posterolateral margins sinuate with external third nodulose and with four long and broad spines, and internal third smooth; posterior margin straight, smooth; calli flat; triangular process present (Fig. 3). Prosternum with deep concavity; mesosternum, and metasternum non sulcate; mesosternum anteriorly tuberculate between procoxae; metapleural supracoxal spine lacking in both sexes; anterior lobe of metathoracic peritreme auriculiform, and fused with posterior lobe almost truncated. *Legs*. Fore femur slender, armed ventrally with one row of spines, and dorsal surface with small tubercles; middle femur slender, armed ventrally with one row of internal spines, and one row of external tubercles, and dorsal surface minutely tuberculate; hind femur in both sexes extending far from the apex of the last abdominal segment, moderately robust, without basal dorsal spine, armed ventrally with two rows of broad spines, and dorsal surface densely tuberculate, intermixed with few broad spines; hind tibiae cylindrical, not expanded, sulcate, in males armed internally with one row of small spines, in females unarmed. *Scutellum*. Triangular, flat, longer than wide, with apex subacute. *Hemelytra*. Macropterous, extending beyond apex of abdomen; apical margin narrowed, long, extending beyond middle third of hemelytral membrane. *Abdomen*. Posterior angles of connexival segments II to VI entire, not spined; upper margin of male connexival segments III to VII spined and tuberculate along entire edge, in females scattered with few tubercles; abdominal sterna without medial furrow; abdominal spiracles closer to upper edge, than to anterior or posterior border of each sternite. *Male genitalia*. Genital capsule with posteroventral edge laterally produced into short blunt lobes, and between them with small sized concavity (Fig. 4), or lateral angles straight, with deep "V" concavity (Fig. 5), or with broad medial plate, scarcely exposed and slightly sinuate, and with lateral angles depressed (Fig. 6). *Female genitalia*. Abdominal sternite VII with plica and fissura; plica transversely straight; gonocoxae I triangular, in caudal view close; paratergite VIII subtriangular, with visible spiracle; paratergite IX squarish, longer than paratergite VIII. *Integument*. Body surface dull, without metallic reflections; collar, posterior lobe of pronotal disc, scutellum, clavus, corium, acetabulae, posterior half of thoracic propleura, and posterior margin of mesopleura and metapleura densely punctate; head, callar region, anterior half of propleura, great portion of mesopleura and metapleura, sternal region of thorax, abdomen, male genital capsule, and female genital plates impunctate; pronotal disc not nodulose; head, pronotum, legs, mesosternum, metasternum, and abdominal sternite clothed with long erect bristle like-setae; clavus, corium, propleura, mesopleura, and metapleura, and antennal segments I to IV clothed with short decumbent to suberect bristle like-setae.

Discussion. This genus is closely related to *Petalops* Amyot & Serville, sharing with it the following characters: hind tibia simple, not expanded; rostrum never reaching the abdomen, rostral segment III never the shortest; scutellum clearly longer than wide; metathoracic peritreme with two lobes; and humeral angles of pronotum acute. *Cleotopetalops* new genus, differs primarily by the following combination of characters: humeral angles conspicuously produced into sharp spines turned upward and slightly backwards (Fig. 3); metapleural supracoxal spine lacking in both sexes; hind femur of males moderately slender, and basally without a dorsal spine; hind tibiae of males internally with one row of small spines; and general color of the body without metallic reflection. Additional characters are the tylus in lateral view scarcely raised above dorsal level of antenniferous tubercles, and antennal segment I longer than II. In *Petalops* the humeral angles are slightly spined (Fig. 2), the metapleural supracoxal spine is present in males, and lacking in females, the hind femora of males are strongly incrassate with a clear dorsal spine basally, the hind tibiae of males have one row of strong and broad spines internally, and the general color of the body has metallic reflections. The tylus in lateral view is conspicuously raised above the dorsal level of the antenniferous tubercles, and antennal segment II is longer than I. *Cleotopetalops* also resembles *Stenometapodus* Breddin in the condition of the pronotal disc without tubercles, the humeral angles acute, the upper margins of male connexival segments III to VII spined and tuberculate along their entire edges, and the scutellum with erect bristle like-setae. *Stenometapodus* is distinguished easily by having the hind tibia expanded, widely in females, more narrowly in males, the inner face of female hind tibiae strongly spined, the hind femur strongly incrassate, the posterior angles of connexival segments V–VI spined, and the humeral angles exposed, with medium sized spines (Fig. 1). In *Cleotopetalops* the hind tibia in both sexes are simple, slender and not expanded, the inner face of female hind tibia is unarmed, the hind femur moderately slender, the posterior angles of connexival segments V–VI are smooth and not spined, and the humeral angles remarkably produced into sharply spines (Fig. 3).

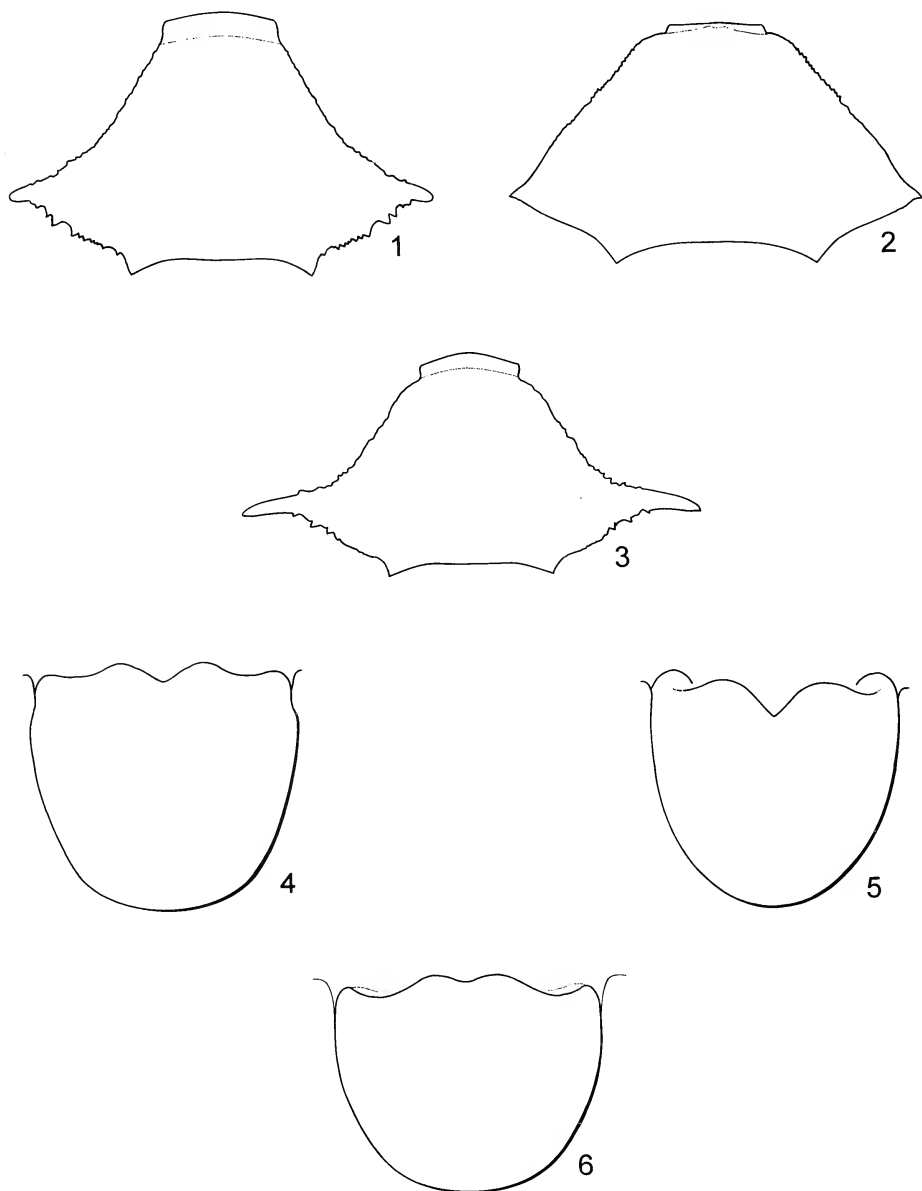
Etymology. From the Greek, *cleotos*, meaning collar, referring to the distinctive pronotal collar, and *Petalops*, for the close genus.

Type species. *Cleotopetalops bicolor*, new species.

***Cleotopetalops bicolor*, new species**

Figs. 3–4

Description. *Male. Dorsal coloration.* Head black with inner face of antenniferous tubercles and narrowed longitudinal stripe running between ocelli until base of tylus yellow; antennal segments I to III bright chestnut orange, and IV reddish brown; pronotum black; scutellum black with apex dirty yellow; clavus black with claval suture pale yellow; corium black with apical angle and broad and curved longitudinal stripe running through endocorium pale yellow; hemelytral membrane black with veins pale grey; connexival segments II to VI dirty yellow with inner margin black, and upper border reddish brown; connexival segment VII black with anterior angle dirty yellow, and upper border reddish brown; dorsal abdominal segments black with broad dirty yellow stripe running through middle third of II to anterior margin of segment VII. *Ventral coloration.* Head black; rostral segments I and II chestnut



Figs. 1-6. Structural details of Coreinae. Figs 1-3. Shape of pronotum. Fig. 1. *Stenometaopodus v-luteum* Breddin. Fig. 2. *Petalops distinctus* Montandon. Fig. 3. *Cleotopetalops bicolor* new species. Figs. 4-6. Male genital capsule in caudal view of *Cleotopetalops* spp. Fig. 4. *C. bicolor* new species. Fig. 5. *C. polheimi* new species. Fig. 6. *C. cyanocephalus* new species.

brown with orange reflections, and segments III and IV bright orange (apex of IV brown); thorax black with acetabulae, anterior and posterior lobe of metathoracic peritreme, evaporative area, coxae and trochanters bright orange; fore and middle leg, with femora, tibiae and tarsi bright chestnut red; hind femur black to dark reddish brown with basal joint bright chestnut red; hind tibia bright chestnut red, with apical joint yellow; hind tarsi with basal segment bright orange, and middle and apical segments bright chestnut red; abdominal sterna black with pleural margin II to VI and anterior half of VII yellow; genital capsule black. *Structure*. Triangular process of posterior margin of pronotum scarcely developed. *Genital capsule*. Posteroventral edge laterally produced into short blunt lobes, and between them a small sized concavity (Fig. 4).

Measurements. Length head: 1.77; width across eyes: 2.20; interocular space: 0.90; interocellar space: 0.50; length of antennal segments: I, 4.75; II, 4.10; III, 3.35; IV, 8.40; length of rostral segments: I, 1.30; II, 1.19; III, 1.30; IV, 1.25. Pronotum length: 3.60; width across frontal angles: 1.90; width across humeral angles: 6.80. Scutellar length: 2.17; width: 1.85. Total body length: 16.05.

Female. Similar to male. Apex of scutellum reddish brown to black; connexival segments VIII and IX black; dorsal abdominal segments VIII and IX black with middle third of anterior margin dirty yellow; rostral segment I bright chestnut red, segment II with external face bright chestnut red, and internal face bright orange, and segments III and IV bright orange (apex of IV brown); abdominal sterna black with pleural margins II to anterior third of VII, and two broad longitudinal stripes running lateral to middle line through II to VI abdominal sterna dirty yellow; genital plates black.

Measurements. Length head: 1.85; width across eyes: 2.30; interocular space: 0.90; interocellar space: 0.50; length of antennal segments: I, 4.67; II, 3.77; III, 3.18; IV, 8.95; length of rostral segments: I, 1.45; II, 1.25; III, 1.35; IV, 1.30. Pronotum length: 3.75; width across frontal angles: 2.00; width across humeral angles: 6.75. Scutellar length: 2.50; width: 2.15. Total body length: 18.15.

Types. Holotype, ♂, ECUADOR, **Napo**, 20 km E of Puerto Napo, Aliñahui, 1°03'S, 77°40'W, 450 m, ii.1991, E. S. Ross (CAS). Paratypes: 1 ♂, 1 ♀, ECUADOR, **Napo**, vic. Puerto Misahuali, 1°2'4.2"S, 77°39'49.2"W, 1650–1900', 6–19.ix.1998, J. E. Eger (EGER, UNAM).

Etymology. Named for the two colored appearance of the corium.

Distribution. Known only from Ecuador.

Cleotopetalops cyanocephalus, new species

Fig. 6

Description. *Male*. *Dorsal coloration*. Head black with inner face of antenniferous tubercles, and narrowed longitudinal stripe running between ocelli until base of tylus yellow; antennal segments I to IV black to reddish brown; pronotum dirty chestnut orange with collar, calli, posterior margin and humeral angles black; scutellum black with apex dark chestnut orange; clavus and corium black with costal border and apical angle dark chestnut orange; connexival segments III and IV black with upper margin dirty yellow, segments V and VI yellow, and VII black with anterior third yellow; dorsal abdominal segments II to VI black, and VII black with yellowish

quadrate spot located at middle third of anterior margin. *Ventral coloration.* Head black with buccula and rostral segments I to IV (apex of IV black) bright chestnut orange; collar, prosternum, mesosternum and thoracic metasternum, anterior margin of propleura and mesopleura, the totality of metapleura, anterior and posterior lobe of metathoracic peritreme, and evaporative area bright chestnut orange; coxae, trochanters, and anterior third of femora bright chestnut orange; femora and tibiae black to reddish brown; outer face of each segment of fore and middle tarsi reddish brown and inner face dirty yellow; hind tarsus with basal and middle segments entirely pale yellow, and distal segment with outer face reddish brown, and inner face dirty orange; abdominal sternite III black with two broad dirty yellow longitudinal stripes lateral to midline, sternite IV to VI black with pleural margin yellow green, and segment VII black with anterior third yellow green; genital capsule black. *Structure.* Triangular process of pronotum well developed. *Genital capsule.* Posteroventral edge with broad, median plate, scarcely exposed and sinuate, and with lateral angles depressed (Fig. 6).

Measurements. Length head: 1.93; width across eyes: 2.30; interocular space: 1.00; interocellar space: 0.47; length of antennal segments: I, 4.95; II, 4.25; III, 3.65; IV, 8.20; length of rostral segments: I, 1.29; II, 1.14; III, 1.19; IV, 1.25. Pronotum length: 3.55; width across frontal angles: 2.00; width across humeral angles: 7.05. Scutellar length: 2.20; width: 1.90. Total body length: 17.55.

Female. Unknown.

Types. Holotype, ♂, ECUADOR, **Sucumbios**, Cuyaesno, 230 m, 13–25.vii.1992, Thantanoar (PUCE).

Discussion. *Cleotopetalops cyanocephalus*, new species, is easily recognizable by the broad medial plate of the posteroventral edge of the male genital capsule (Fig. 6) and by having the pronotal disc dirty chestnut orange with only the collar, calli, posterior margin and humeral angles black. In *C. bicolor* the pronotum is entirely black, and the posteroventral edge of male genital capsule has a small sized concavity (Fig. 4).

Etymology. Named for the dark coloration of the head; from the Greek, *Cyaneos*, dark, and *cephale*, head.

Distribution. Known only from Ecuador.

***Cleotopetalops polhemi*, new species**

Figs. 5, 7

Description. *Male. Dorsal coloration.* Head black with inner face of antenniferous tubercles, and narrowed longitudinal stripe running between ocelli until base of tylus yellow; antennal segment I to IV black; pronotum, scutellum (apex dirty yellow), and clavus reddish black; corium reddish black with costal border dirty yellow and veins chestnut orange; connexival segments with upper margin dirty yellow and inner margin black; dorsal abdominal segments black with dirty yellow spots on posterior margin of segments V and VI, anterior margin of VI and middle third of VII. *Ventral coloration.* Head reddish brown with buccula, longitudinal stripe running lateral to middle line behind eyes, and rostral segments I to IV (apex of IV black) chestnut orange; acetabulae, anterior and posterior lobe of metathoracic peritreme, evaporative area, prosternum, mesosternum, coxae and trochanter bright orange; propleura, me-

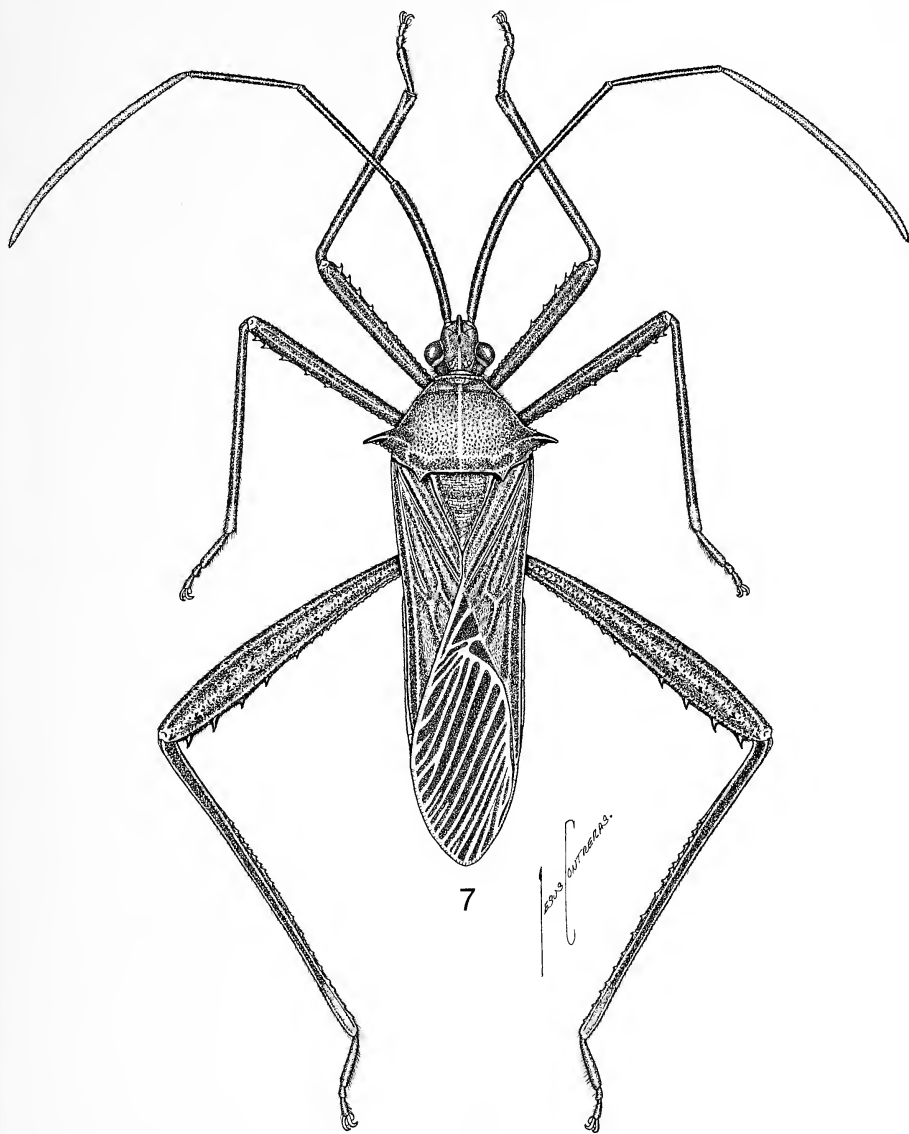


Fig. 7. Dorsal view of *Cleotopetalops polhemi* new species.

sopleura and thoracic metapleura bright chestnut orange red; metasternum dull chestnut orange; fore and middle leg pale chestnut orange with basal joint of femora, apical joint of tibiae and middle and apical segments of tarsi yellow; hind femur bright reddish brown with basal joint bright orange; hind tibia pale chestnut orange with apical third pale yellow; hind tarsus with basal segment yellow and middle and hind segment pale chestnut orange; abdominal sterna and genital capsule black; rim

of abdominal spiracle black, and adjacent area dirty yellow; pleural margin scattered with irregular dirty yellow marks. *Structure*. Triangular process of pronotum conspicuously produced. *Genital capsule*. Posteroventral edge with lateral angles straight, with deep "V" concavity (Fig. 5).

Measurements. Length head: 1.87; width across eyes: 2.12; interocular space: 0.80; interocellar space: 0.40; length of antennal segments: I, 4.95; II, 4.40; III, 3.55; IV, 8.40; length of rostral segments: I, 1.22; II, 1.25; III, 1.30; IV, 1.27. Pronotum length: 3.55; width across frontal angles: 1.75; width across humeral angles: 6.05. Scutellar length: 2.25; width: 1.90. Total body length: 17.48.

Female. Similar to male. Head ventrally black with buccula and rostral segments I to IV (apex of IV black) bright chestnut orange; connexival segments VIII and IX, dorsal abdominal segments VIII and IX, and genital plates black to dark reddish brown; abdominal sterna black with pleural margins III to VI and anterior half of VII, two broad longitudinal stripes running lateral to midline on sterna IV and V, middle third of sternite III, and the area adjacent to each abdominal spiracle dirty yellow.

Measurements. Length head: 1.75; width across eyes: 2.10; interocular space: 0.85; interocellar space: 0.42; length of antennal segments: I, 4.10; II, 3.75; III, 3.25; IV, 8.25; length of rostral segments: I, 1.67; II, 1.32; III, 1.12; IV, 1.15. Pronotum length: 3.30; width across frontal angles: 1.90; width across humeral angles: 5.85. Scutellar length: 1.90; width: 1.72. Total body length: 16.20.

Types. Holotype, ♂, PERU, **Madre de Dios**, Rio Tambopata, Res. 30 air km SW Pto. Maldonado, 290 m, 6-10.xi.1979, J. B. Heppner, subtropical moist forest (USNM). Paratypes: PERU: 1 ♂, same data as holotype (USNM); 1 ♀, Saposá, 320 m, 1-6.ix.1948, C. Bolívar (UNAM).

Discussion. *Cleotopetalops polhemi*, new species, like *C. cyanocephalus* has the corium black without a yellow longitudinal stripe, and the triangular process of pronotum well developed. Is recognized by the shape of the posteroventral edge of the male genital capsule (Figs. 5-6) and by having the pronotal disc entirely black, and not almost dirty chestnut orange characteristic of *C. cyanocephalus*.

Etymology. This new species is named in honor of a long time friend, John T. Polhemus, in recognition of his many contributions to the systematics of the aquatic and semiaquatic bugs.

Distribution. Known only from Peru.

KEY TO THE SPECIES OF *CLEOTOPETALOPS*

1. Corium black with broad longitudinal yellow stripe running through endocorium; triangular process of pronotum small; posteroventral edge of male genital capsule with small sized concavity (Fig. 4) *C. bicolor*, new species
- Corium black without yellow longitudinal stripe; triangular process of pronotum well developed; posteroventral edge of male genital capsule with another condition (Figs. 5-6) 2
2. Pronotal disc entirely black; posteroventral edge of male genital capsule with deep V-shaped concavity (Fig. 5) *C. polhemi*, new species
- Pronotal disc dirty chestnut orange, with collar, calli, posterior margin and humeral angles black; posteroventral edge of male genital capsule with broad median plate slightly sinuate (Fig. 6) *C. cyanocephalus*, new species

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LITERATURE CITED

- Brailovsky, H. 1997. One new genus and two new species of Acanthocephalini (Hemiptera: Coreidae: Coreinae). *Ann. Entomol. Soc. Am.* 90:550–554.
- Packauskas, R. J. 1994. Key to the subfamilies and tribes of the New World Coreidae (Hemiptera), with a checklist of published keys to genera and species. *Proc. Entomol. Soc. Wash.* 96:44–53.

NEW SPECIES OF LETHAEINI FROM MADAGASCAR (HETEROPTERA: LYGAEOIDEA: RHYPAROCHROMIDAE)

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Abstract.—Three new species of *Neolethaeus* and one of *Lethaeus* are described from Madagascar. One of these (*Neolethaeus madagascariensis*, new species) is related to a West African species. These species represent some of the most striking species of a large complex that radiates on the island. Dorsal views are given for *Neolethaeus polhemi*, new species and *Lethaeus gigas*, new species. Illustrations of the clasper, sperm reservoir and genital capsule are included for three of the four species. Generic and geographic relationships are discussed.

The Lethaeini constitutes a distinctive and well defined monophyletic tribe within the Rhyparochromidae. It is primarily a tropical and subtropical taxon with only a few genera and species in temperate regions. Many of the species are abundant in the tropics.

Despite early descriptions by Reuter (1887) and Bergroth (1905) the fauna of Madagascar has been little studied. In the present paper we describe four striking species from the great island in honor of Dr. John Polhemus in recognition of his many important contributions to Hemipterology, and especially in admiration for his indefatigable and invaluable field work on all continents including Madagascar.

Despite the important synapomorphies that define the tribe (O'Donnell, 1991; Slater and Woodward, 1980) generic limits in the eastern hemisphere are, in part, unsatisfactory. This is especially true of a complex of medium to large sized species that traditionally included *Lethaeus* and its allies. O'Donnell (1991) points out in her study of the claspers and aedeagus that while the species of *Lethaeus* itself that she examined (4 species) were very similar and appeared to form a monophyletic group, species currently placed in *Neolethaeus* show three very dissimilar sperm reservoirs and she believes the genus to be polyphyletic.

It is beyond the scope of this paper to attempt to untangle the cladistic relationships of species now listed in *Neolethaeus*. However the Madagascar species described below are assigned to that genus by virtue of the following characteristics: 1. Pronotum with a v-shaped, punctate anterior pronotal collar which is delimited posteriorly by a series of punctures rather than as an impressed line. 2. Male hind femora enlarged and bearing a series of setiferous tubercles in addition to socketed spines. 3. A large metapleural evaporative area that covers the inner one-third to one half of the mesopleuron and has the outer (dorsal) margin straight or nearly so (truncate). 4. An anteriorly placed spine on the explanate pronotal margins. 5. Paired iridescent areas on the head that are non-striate. 6. Long holding sclerites that unite distally in a "v."

It should be noted that the Madagascar lethaeine fauna will undoubtedly prove to be quite extensive. In addition to the previously described species (*L. longirostris*

Reuter, *L. nodulinervis* Bergroth) we have before us one or more examples of at least ten additional species, most belonging to the *Lethaeus-Neolethaeus* complex as well as species related to *Noteolethaeus* and *Camptocera*. It seems probable that as with many other groups of plants and animals, the Lethaeini will have radiated widely on the island.

While nothing really significant is known of the biology of any of the Madagascar species, there is a strong suggestion from the specimen label data that these insects are associated with forest rather than savannah. O'Donnell (1986) notes that many Lethaeini appear to be associated with more mesic habitats than many other rhyparochromines. The striking elongate labium of many species suggests feeding on seeds imbedded in fruits such as *Ficus* (note the similar condition found in fig-feeding species of Heterogastrinae; Slater 1971.)

Twenty-three genera of Lethaeini are currently recognized from the Eastern Hemisphere (we believe *Orbellis* Distant will prove to be a junior synonym of *Neolethaeus*). O'Donnell (1991) places these genera into four "groups," three of which occur in the Eastern Hemisphere. *Neolethaeus* is placed in "Group III," characterized by apomorphic long v-shaped holding sclerites of the aedeagus. Within this group she believes that *Aristaenetus* Distant, *Lophoraglius* Wagner and *Neolethaeus* probably share a common ancestor because of the highly modified shape of the claspers. Woodward and O'Donnell (1988) discuss the position of *Aristaenetus* in detail and it is not considered further here except to suggest relationship to *Lethaeo-grandellus* Scudder.

The most difficult problem is to ascertain the generic limits of *Neolethaeus* and *Lophoraglius* (*Porrectolethaeus* Scudder, which we have not examined, may also be involved, but it is readily recognizable by the mutic fore femora and the very long head, with the tylus extending anteriorly beyond the end of the first antennal segment; it is known only from Senegal). Species of *Lophoraglius* have a pronotal collar that is usually not strongly produced into a "V" and is limited posteriorly by a distinct linear depression that usually has only a few punctures on the collar. Males tend not to have enlarged hind femora, nor a series of tuberculate spines, but both genera have explanate lateral pronotal margins with an anterior trichobothrium present and similar iridescent areas at the base of the head. Although some species are intermediate in some of these features, we feel that the species described below fit the current, albeit somewhat unsatisfactory, concept of *Neolethaeus*. We recognize that the recognition and definition of monophyletic units within this complex is one of the most desirable desiderata in the systematics of the Lethaeini.

Color nomenclature used in the descriptions follows Smithe (1975, 1981). All measurements are in millimeters. IRSM is the acronym for the Institut Scientifique Madagascar, Paris Museum.

***Neolethaeus polhemi*, new species**

Figs. 1–5

Description. A brightly colored, variegated species, amber on cream color ground. Head, most of pronotal surface, entire scutellum, an irregular but complete transverse corial fascia which attains lateral corial margins, basal and subdistal streaks on clavus and apex of corium amber. Anterior pronotal collar, a broad irregular posterior prono-

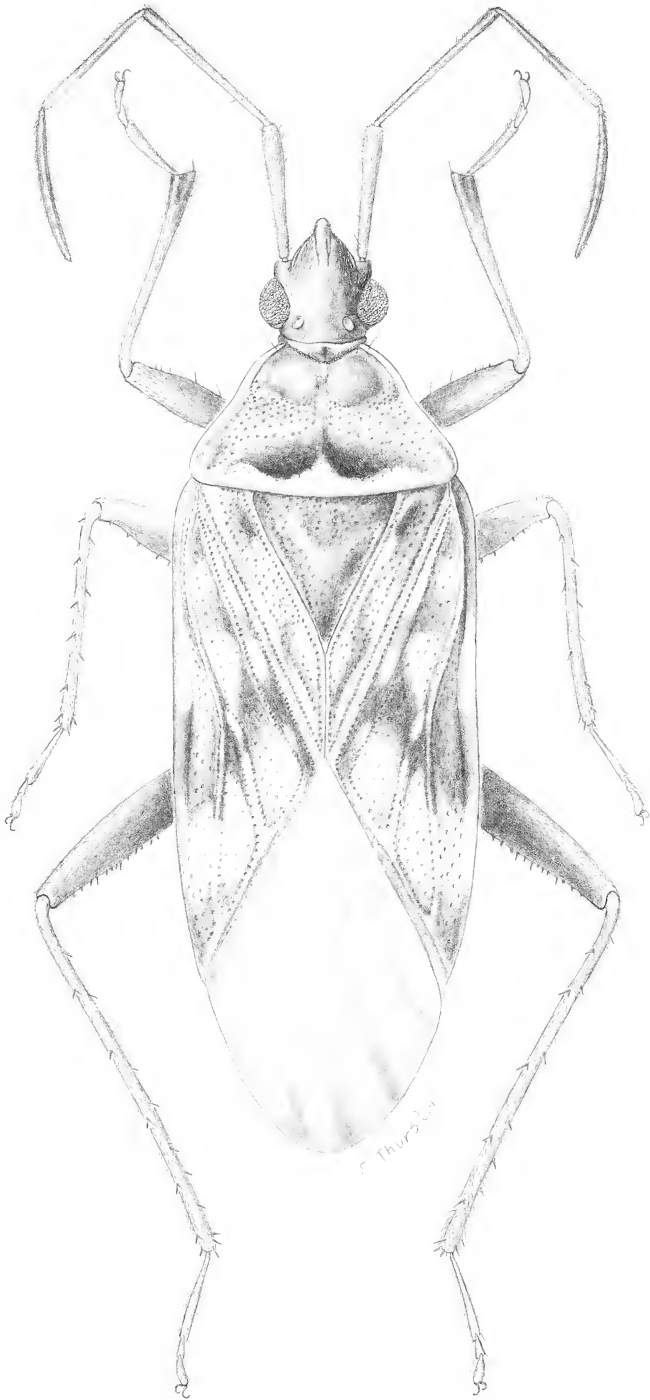
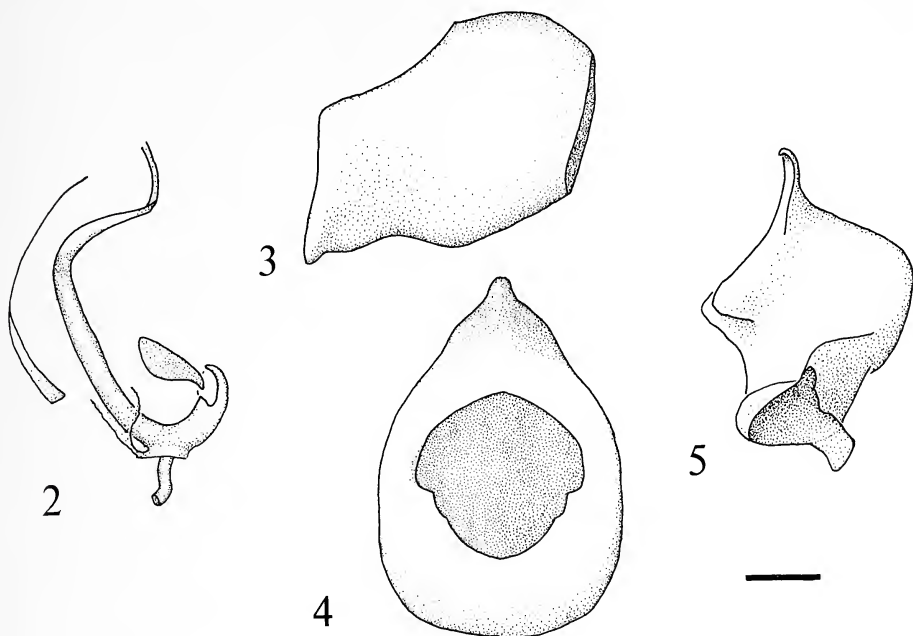


Fig. 1. *Neolethaeus polhemi*, n.sp., dorsal view.



Figs. 2–5. Spermatheca, lateral view, scale line = 0.1mm. Fig. 3. Genital capsule, lateral view, scale line = 0.25mm. Fig. 4. Genital capsule, dorsal view, scale line = 0.25mm. Fig. 5. Clasper, scale line = 0.1mm.

tal margin and narrow explanate lateral margins cream color. Collar dark mesally. Posterior pronotal lobe with a scalloped maroon macula on either side of midline immediately before cream color posterior stripe. Ground color of clavus and corium cream color mixed with darker amber to chestnut markings. Membrane translucent buff. Scutellum amber except for cream apex and subdistal maroon macula. Antennae conspicuously variegated—first segment, proximal $\frac{1}{2}$ of second segment and proximal $\frac{1}{2}$ of third segment amber, distal $\frac{1}{2}$ of third segment cream color, remainder of antennae dusky brown. Femora amber with metafemora darker, approaching maroon; tibiae buff; distal ends of tibiae, first tarsal segment and all of second and third tarsal segments chestnut. Pleuron and sternum nearly uniformly amber. Small inconspicuous light hairs arising from each puncture of dorsal surface, latter absent from calli. Punctures shallow and widely separated over rest of dorsal and pleural surfaces. Claval punctures forming distinct rows, one adjacent to scutellum and another to corium, area between rows with numerous irregularly-spaced punctures.

Head subacuminate, non-declivent, tylus attaining middle of first antennal segment. Ocelli very large, larger than distance between ocellus and compound eye. Head with two large iridescent areas extending nearly to ocelli, not finely striate. Head length 0.82, width 1.20, interocular space 0.60. Pronotum with a well-defined, v-shaped anterior collar bounded posteriorly by a deep line of punctures except at midline. Lateral pronotal margins explanate and upturned. Trichobothrium present on pronotal edge at level of collar. Anterior and posterior lobes differentiated by a

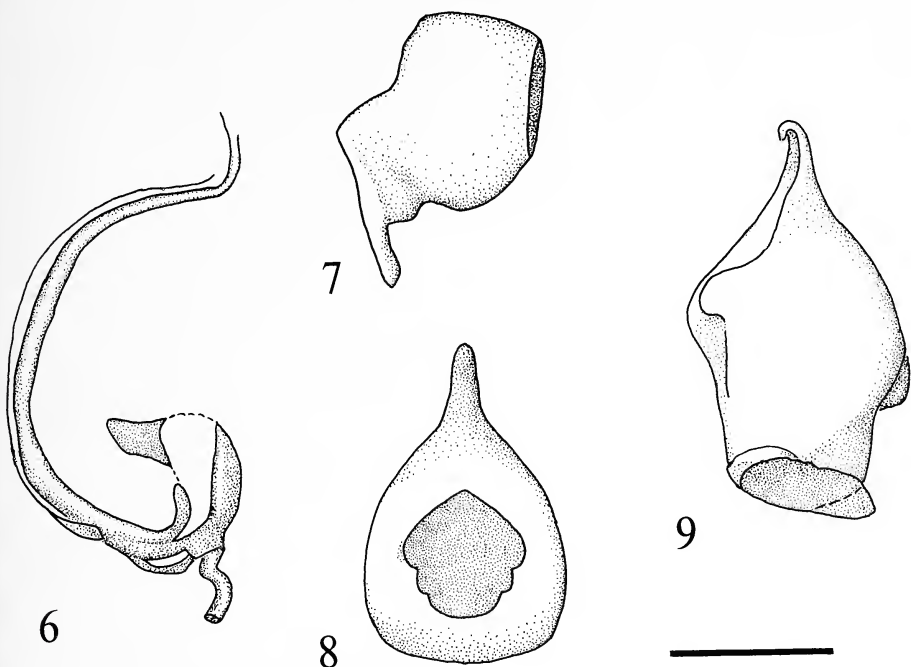
cluster of punctures, more prominent laterally. Posterior pronotal margin evenly convex. Pronotal length 1.40, width 2.42. Scutellum lacking a median carina, with anterior third depressed mesally. Scutellar length 1.40, width 1.31. Claval commissure length 1.04. Lateral corial margins only slightly widened along length. Midline distance from apex of clavus to apex of corium 1.80. Midline distance from apex of corium to apex of membrane 1.60. Metathoracic scent gland auricle short, slightly curving posteriorly; almost as broad as long; evaporative area with dorso-lateral margin evenly truncate (straight), occupying inner third of metapleuron. Mesopleuron and metapleuron lateral to scent gland slightly swollen, metapleuron with fine striae near lateral margin. Fore and hind femora about equally and only moderately incrassate, former with three sharp ventral spines near distal end, latter with an irregular series of large, thick blunt tuberculate spines along most of length, also bearing a row of widely spaced spines. Labium attaining metacoxae. Length of labial segments (from paratype) I 1.04, II 1.04, III 0.90, IV 0.62. Antennae slender, terete, Length of antennal segments I 1.0, II 1.44, III 1.32, IV 1.44. Total body length 7.72.

Male genital capsule (Figs. 3, 4) with prominent, ventrally bulging projection that ends in a rounded thumb-like protrusion. Clasper (Fig. 5) with blade broad, narrowing abruptly to a pointed recurved tip; shank short; blade and shank concave; bluntly rounded inner projection moderately produced, closer to area of attachment than broadly rounded outer projection; flange present. Sperm reservoir (Fig. 2) with sleeve apparent only basally, arising from spur of base; vesical seminal duct long, narrow, becoming flattened distally beyond strong bend (several distal coils not shown on figure); wings long, relatively broad; holding sclerites long, ribbon-like, meeting distally in a sharp, fully sclerotized "v."

Spermatheca with globose bulb, distal flange not apparent, putative proximal flange asymmetrical, pointed on one side, spermathecal duct broadened and slightly more sclerotized proximal to this.

Types. Holotype, ♂, MADAGASCAR, Est dct. Sambava R. N. XI, Marojejy ouest, 1850 m., ii-60, P. Soga In (IRSM). Paratypes: MADAGASCAR, 3 females, same data as holotype; 2 males, same as holotype except 1600 m., xi-59; 1 female, Est dct. Sambava R. N. XII Marojejy Beondroka, 1200 m, vi-60, P. Soga; 1 male, Est Ankasoka, 1130 m., dct. Morainanga, 21.x.57, P. Griveaud; 1 female, Est Ankalampona, 130 m., Navana-Maraoantsetra, iii-58, Soga Ramarizonina; 1 male, Est dct. Tamatave Ambodihatafana (Rte. Fenerive est), x-58, Randimby; 1 male, 1 female, Centre dct. Ambohimahasoa foret Tsarafidy, 1450 m., xii-59 & I-60, P. Griveaud; 1 male, Andranotobaka, alt. 1400 m., Amatolampy, iii-57, P. Griv.; 1 female, same data except iv-57 (all above in IRSM and J. A. Slater collections).

Variation. There is considerable sexual dimorphism, especially in the development of the hind femora which in the females are scarcely enlarged and at most have 3-4 small well-separated spines present. The fore femoral spines are very small in females. Some males have the hind femora more strongly incrassate than the fore femora. The dark area posteriorly on the pronotum mesally just before the basal yellow stripe is sometimes reduced to an irregular dark stripe rather than an ovoid area. The apex of the scutellum sometimes is dark and this dark area may extend some distance up the apical area of the scutellum as a mesal stripe.



Figs. 6–9. *Neolethaeus madagascariensis*, n.sp. Fig. 6. Sperm reservoir, lateral view, scale line = 0.25mm. Fig. 7. Genital capsule, lateral view, scale line = 1mm. Fig. 8. Genital capsule, dorsal view, scale line = 1mm. Fig. 9. Clasper, scale line = 0.25mm.

Neolethaeus madagascariensis, new species

Figs. 6–9

Description. A large, robust, broadly elliptical species. Head with a large ovoid macula on either side of midline posteriorly on pronotum immediately before buff yellow posterior margin, femora, first, fourth, distal $\frac{1}{2}$ and proximal $\frac{2}{3}$ of second and third antennal segments dusty brown. Pronotum bright chestnut over most of surface with anterior collar, explanate lateral margins and narrow posterior margin buff-yellow (latter not extending over lateral $\frac{1}{3}$ of posterior margin). Scutellum and hemelytra nearly uniformly russet. Apex of tibiae and all of tarsi dusky brown to black. An obscure series of three lighter streaks along Cu adjacent to claval suture and one at junction of Sc and R+M. Proximal $\frac{2}{3}$ of antennal segment two buff, distal $\frac{1}{3}$ of antennal segment three cream color. Essentially glabrous dorsally, tiny scattered decumbent hairs present. Punctures well separated from one another, conspicuous on posterior half of pronotum, scutellum and entire hemelytra, those on anterior pronotal collar, pronotum and scutellum dark, otherwise concolorous with ground color of body. Calli impunctate, head inconspicuously rugose.

Head acuminate, non-declivent, tylus reaching about middle of first antennal segment. Head length 1.38, width 1.70, interocular space 1.00. Pronotal v-shaped anterior collar well developed, punctate. Lateral pronotal margins broadly explanate,

with trichobothrium present at anterior corner; posterior pronotal margin slightly convex. Pronotal length 2.10, width 3.66. Scutellum with a slightly swollen Y-shaped elevation on an impunctate line in middle, lacking a distinct elevated carina. Scutellar length 2.86, width 2.02. Hemelytral R+M vein strongly elevated and carinate, lateral corial margins nearly straight. Claval commissure length 1.20. Midline distance from apex of clavus to apex of corium 2.38. Midline distance from apex of corium to apex of body 1.60. Evaporative area well developed, truncate distally. Lateral (dorsal) margins of pleura with finely striate areas, that of metapleuron slightly raised, conspicuous. All femora incrassate. Fore femur with four sharp spines distally on ventral surface and three to four elongate tuberculate spinules. Middle femur with short spines in one row and coarse tubercles in another row. Hind femur with very large coarse tubercles over entire ventral surface. Antennae slender, terete. Length of antennal segments I 1.38, II 2.20, III 1.84, IV 1.84. Labium very elongate extending posteriorly almost to abdominal sternum five. Length of labium (from female paratype) I 2.31, II 2.46, III 2.80, IV 1.16. Total body length 9.04.

Male genital capsule (Figs. 7, 8) with long, finger-like extension projecting ventrally from posterior rim. Clasper (Fig. 9) with blade broad, tip pointed, recurved; blade and shank concave; shank reduced; inner projection bluntly rounded; outer projection broadly rounded, closer to area of attachment than inner projection. Sperm reservoir (Fig. 6) with sleeve apparently fused with vesical seminal duct; vesical seminal duct long, narrow, with a thickened kink and several distal coils (not shown on figure) and two curving extensions proximally, opposite arcuate extension; wings duck-bill shaped; holding sclerites long, narrow, ribbon-like, meeting distally to form a "v", less sclerotized where they join.

Spermatheca with very long duct, narrow for most of its length but broadening abruptly about one bulb diameter from bulb, where proximal flange apparently becomes part of duct; proximal flange an asymmetrical, horseshoe-shaped sclerite; distal flange not apparent.

Types. Holotype, ♂, MADAGASCAR, Andobo, 190 m., Forêt Antsingy, dct. Antsalova, ii-57, P. Griv (IRSM). Paratypes: 1 male, 2 females, same data as holotype (IRSM and J. A. Slater collections).

Discussion. This striking species, while belonging to a complex well represented on Madagascar, is actually most closely related to the West African species *Neolethaeus giganteus* Scudder. This appears to be another example of the affinities of the old forest fauna, of which many elements now appear to be isolated in West Africa and Madagascar, with Oriental and South African isolates also represented.

Neolethaeus madagascariensis differs from *N. giganteus* in a number of features. The West African species has a distinct pale line through the middle of the pronotum, a pale yellow rather than black first antennal segment, a less elongate tapering head, and relatively shorter antennae—in *N. giganteus* the head width is greater than the length of the third antennal segment, whereas the reverse is true in *N. madagascariensis*. The genital capsules are also strikingly different. *N. giganteus* has a relatively broader more arcuate pronotum. This can be expressed as the former having the ratio of the width of the pronotum across the humeral angles compared to the width measured at the level of the posterior margin of the anterior collar only 1.33, whereas in *N. madagascariensis* the ratio is well over 1.4.

Scudder (1963) described his species from Ibadan, Nigeria (type series) and from

Sierra Leone. His description is of a female as apparently the male was not in good condition. However, his measurement of the pronotal width must be in error as he reports it as 1.41 and the length as 1.94. In the specimens we have examined the pronotal width is always considerably greater than the length.

We have examined the following material of *N. giganteus*: NIGERIA: 1 male, Univ. of Ibadan, 28.v.49, A. U. Oboite (at light); 1 male, U-I-Campus, 1.ii.71, "under leaves 589," A. U. Oboite; 1 male, 1 female, Ile-Ife W. State, 9.iii.75, J. T. Medler; 1 male, Udo F. R. MW State, 11.iv.75, J. T. Medler. GHANA: 1 female, Tafo, 27.vii.66, Leston ("ant ecology sample 132 46b"); 1 female, Tafo, 3.viii.66, D. Leston ("ant ecology sample 152b") (all above in J. A. Slater collection).

***Neolethaeus maculosus*, new species**

Description. Head, calli area of pronotum, scutellum and a broad, complete transverse hemelytral fascia ferruginous. Distal end of scutellum burnt umber grading to dark grayish brown. Pronotum posterior to calli shading from buff yellow across posterior margin anteriorly to cinnamon. Anterior pronotal collar and explanate lateral margins shading from buff yellow to chestnut. Clavus and corium anterior to dark transverse fascia tawny. Lateral corial margin with a small, elongate triangular buff yellow macula at level of anterior half of claval commissure. A very large cream color apical corial macula, extending mesally to vein Cu. Membrane translucent cinnamon. Legs buff. Antennae with distal end of segment two, proximal $\frac{2}{3}$ of segment three and all of segment four dusky brown. Rest of antennae orange-rufous with distal area of segment three almost cream color. Essentially glabrous above, a few scattered inconspicuous tiny hairs present. Head inconspicuously rugose; calli with a few obscure tiny punctures, remainder of dorsal surface, including anterior pronotal collar, with prominent punctures but these well separated from one another. Clavus with one regular row of punctures along claval and corial suture, otherwise covered with a field of irregular punctures.

Head non-declivent, tylus almost attaining middle of first antennal segment. Ocelli very large, larger than distance from ocellus to compound eye. Iridescent areas at base of head double, not finely striate. Head length 1.20, width 1.30, interocular space 0.68. Anterior pronotal collar strongly differentiated, V-shaped, with a line of punctures delineating posterior margin. Lateral margins of pronotum strongly explanate, nearly evenly tapering anteriorly from humeral angles. A conspicuous seta at level of posterior margin of pronotal collar. Posterior pronotal margin shallowly convex. Pronotal length 1.56, width 2.75. Scutellum slightly swollen, lacking a median carina, depressed mesally near base. Scutellar length 1.52, width 1.48. Claval commissure length 0.94. Midline distance from apex of clavus to apex of corium 1.80. Midline distance from apex of corium to apex of body 1.44. Dorsal (lateral) margin of metapleuron with a series of fine striae. Mesopleuron with much less conspicuous striae. Metathoracic scent gland auricle about as wide as long, subelliptical, not curving posteriorly, distal end blunt. Evaporative area very large, distally truncate. Fore femur moderately incrassate with 4 short sharp black spines distally on ventral surface with a socketed spine immediately proximad. Middle femur and hind femur with two rows of short sharp spines, four posteriorly, five anteriorly. Tibiae with large sharp spines through entire shaft. Antennae slender, terete. Length

of antennal segments I 1.24, II 1.46, III 1.28, IV 1.44. Labium extending posteriorly between metacoxae. Length of labial segments I 1.20, II 1.12, III 1.08, IV 0.70. Total body length 8.54.

Types. Holotype, ♀, MADAGASCAR, Reserve Nat. III. Anbatovositra, Anoranomalaza, i-57, P. Soga (IRSM).

Comments. Although structurally rather similar to *N. polhemi*, the striking coloration, especially the contrast of the enormous apical corial macula with the remainder of the hemelytra, indicates that this is certainly a distinct species.

***Lethaeus gigas*, new species**

Figs. 10-14

Description. A very large robust species. Head maroon with warm sepia to cinnamon rufous tylus. Anterior pronotal lobe shining, chestnut; posterior lobe cinnamon rufous with a buff yellow ovoid macula along posterior margin mesad of raised humeral angle; explanate pronotal margins cream color. Scutellum cinnamon rufous laterally becoming maroon basally. Hemelytra buff yellow with five obscure maroon maculae on corium. An irregular, obscure cream color macula on corium at level of distal fifth of scutellum. Membrane buff with veins buff yellow. Antennae and legs buff to buff yellow, distal end of antennal segment two and apical half of segment four maroon. Pleural and ventral surfaces nearly uniformly maroon. Abdomen chestnut.

Head non-declivent, tylus reaching proximal third of first antennal segment. Iridescent areas at base of head large, ovoid, almost attaining ocelli laterally, finely striate. Head length 1.80, width 2.00, interocular space 1.06. Pronotum with distinct anterior and posterior lobes. Anterior pronotal lobe convexly swollen, much higher than posterior lobe, polished, shining, with an anterior collar-like area composed of coarse punctures and V-shaped, but delimited posteriorly only by a series of closely set punctures. Posterior pronotal lobe subshining, relatively flat and coarsely punctate. Lateral pronotal margins explanate, constricted between anterior and posterior lobes; posterior pronotal margin straight. Pronotal length 3.24, width 4.14. Scutellum with a smooth elevation immediately mesad of lateral line of punctures, central area depressed. Scutellar length 2.70, width 2.36. Clavus with three distinct rows of punctures with numerous irregularly placed punctures between inner row lying adjacent to scutellum and regular row along vein P. Claval commissure length 1.18. Midline distance from apex of clavus to apex of corium 2.70. Midline distance from apex of corium to apex of body 2.06. Mesosternum with somewhat flattened area mesally with a series of fine ridges on either side of groove for labium. Metathoracic scent gland auricle linear, longer than wide, not curving posteriorly, sub-elliptical with blunt apex. Evaporative area occupying only ventral third of metapleuron with outer margin almost straight (truncate). Pleura strongly shining. Metapleuron with series of fine striate ridges laterally. Fore femur strongly incrassate, armed below at distal end with three short sharp, black tipped spines and an additional much larger ventral spine somewhat proximad, ventral surface shallowly grooved distally, remainder of surface with numerous small dark tubercles (these also numerous on mutic middle femur). Hind femur not incrassate, bearing ventrally near distal end a single very small inconspicuous spine-like hair. Middle and hind tibiae with a number of stout

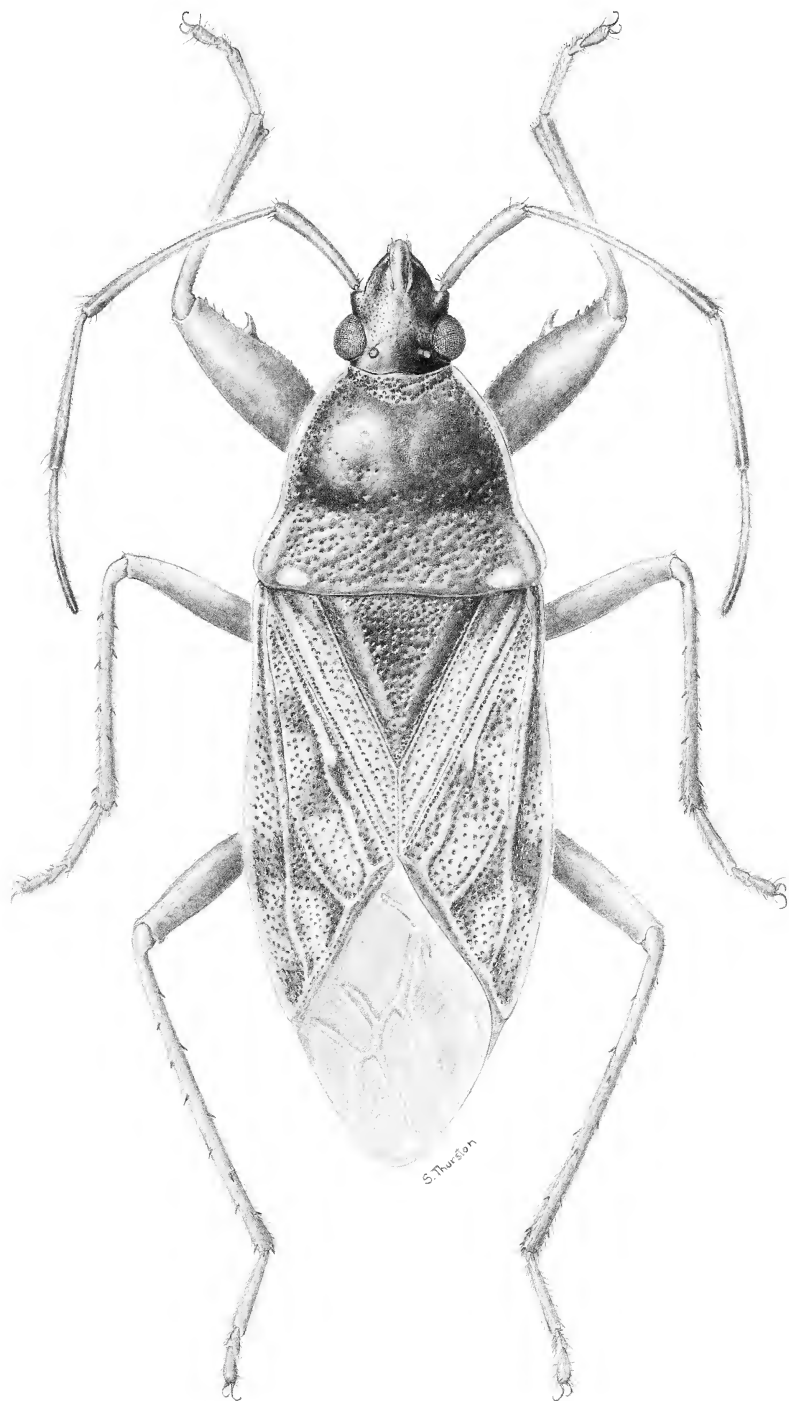
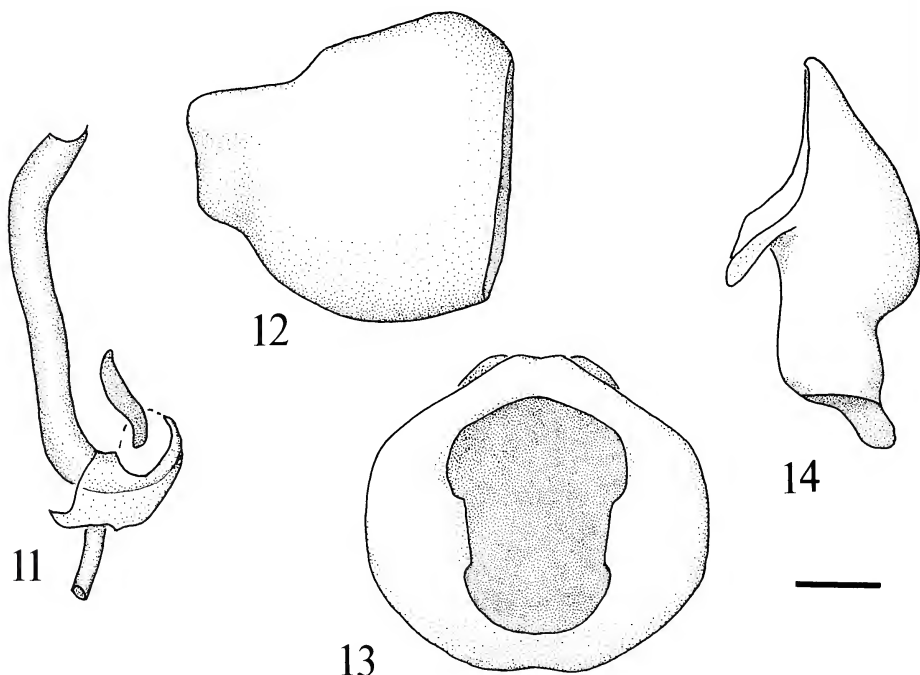


Fig. 10. *Lethaeus gigas*, n.sp., dorsal view.



Figs. 11-14. Fig. 11. Sperm reservoir, lateral view, scale line = 0.1mm. Fig. 12. Genital capsule, lateral view, scale line = 0.25mm. Fig. 13. Genital capsule, dorsal view, scale line = 0.25mm. Fig. 14. Clasper, scale line = 0.1mm.

dark spines. Head with small punctures dorsally, punctate ventrally; remainder of dorsal surface other than anterior pronotal lobe with large coarse punctures, those on hemelytra dark and strongly contrasting with ground color of body surface. Antennae slender, filiform, fourth segment not fusiform. Length of antennal segments I 1.80, II 3.10, III 2.34, IV 2.08. Labium very elongate, extending caudally onto fifth abdominal sternite. Second segment with distal portion "bowed" and widened. Length of labial segments (from paratype) I 2.56, II 1.38, III 1.54, IV 0.58. Total body length 13.87.

Types. Holotype, ♂, MADAGASCAR, Ile Sainte-Marie Forêt de Kalaloo, x-60, P. Griveaud (IRSM). Paratypes: MADAGASCAR: 2 females, same data as holotype; 1 male, same data as holotype except iii-60, Andria R.; 1 male, Ile Sainte-Marie Imbohidena, iv-59, R. E.; 3 females, Est Ambodivoangy, 20 m, dct Maroantsetra, iii-53, Soga-Raharizonina; 1 female, Est Ivontaka, 8 m., dct Maroantsetra, iii-58, Soga-Raharizonina; 1 male, 3 females, Est Ankalampona, 130 m, Navana-Maroantsetra, iii-58, Soga-Raharizonina; 1 male, Sambirano Nosy-Be forêt de Lokobe, xii-58, Andria Robinson; 1 male, Est dct. Tamatouve (Rtevers Férêrive. Est) Garotousy, xii-58, R. E; 1 female, Reserfe nat. III Andranomalaza, Ampanalamoosy, R. Saga (IRSM and J. A. Slater collections).

Variation. The maroon maculae on the corium varies greatly, in some specimens the corium is largely maroon with buff interspaces, in others the maroon maculae

tend to coalesce posteriorly and in others they are barely visible. Specimens vary considerably in the amount and degree of dorsal subshining and polished areas. Some of this may be due to grease on the specimens, but sometimes it appears to be variation. This is especially true of the anterior pronotal lobe which varies from completely shining as in the holotype to as dull as the posterior lobe in some of the paratypes. Females have the anterior pronotal lobe less strongly swollen than do most males, and have much smaller major fore femoral spines. One male paratype has a double large spine on the left femur.

ACKNOWLEDGMENTS

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LITERATURE CITED

- Bergroth, E. 1905. Rhynchota Aethiopica IV. Annales Société Entomologique Belgique 49: 368–378.
- O'Donnell, J. E. 1986. Systematics of Western Hemisphere Lethaeini (Insecta: Hemiptera: Lygaeidae). Ph.D. dissertation, U. Connecticut, Storrs, CT 253 pp.
- O'Donnell, J. E. 1991. A survey of male genitalia in Lethaeine genera. (Heteroptera: Lygaeidae: Rhyparochrominae). J. New York Entomol. Soc. 99:441–470.
- Reuter, O. M. 1887. Ad Cognitionem Heteropterorum Madagascariensium. Entomologische Tidskrift 8:77–109.
- Scudder, G. G. E. 1963. The world Rhyparochrominae (Hemiptera Lygaeidae) III. New Rhyparochrominae from the Ethiopian region. Canadian Entomol. 95:1233–1253.
- Slater, J. A. 1971. The biology and immature stages of South African Heterogastrinae with the description of two new species (Hemiptera: Lygaeidae). Annales of the Natal Museum 20:443–465.
- Slater, J. A. and T. E. Woodward. 1982. Lilliputocorini, a new tribe with six new species of *Lilliputocoris*, and a cladistic analysis of Rhyparochrominae (Hemiptera, Lygaeidae). American Museum Novitates 2754:1–23.
- Smithe, F. B. 1975, 1981. Naturalist's Color Guide. The American Museum of Natural History, N.Y.
- Woodward, T. E. and J. E. O'Donnell. 1988. The genus *Aristaenetus* Distant (Hemiptera: Lygaeidae: Rhyparochrominae) with the description of a new species. Memoirs of the Queensland Museum 25:481–491.

THE GENUS *PERITRECHUS* FIEBER (HEMIPTERA: RHYPAROCHROMIDAE) IN NORTH AMERICA

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Abstract.—The genus *Peritrechus* Fieber in North America is represented by five species, one of which *Peritrechus pilosulus* from California, Oregon and British Columbia is described as new. The species *P. saskatchewanensis* Barber is synonymized with *P. convivus* (Stål), the latter being naturally Holarctic. A key to the species of *Peritrechus* in North America is included. The Palearctic *P. oshanini* Kiritshenko is reinstated as a valid species.

The genus *Peritrechus* Fieber, now placed in the tribe Rhyparochromini within the family Rhyparochromidae, is separable from the other two genera in the tribe in North America by the V-shaped pale mark in the apical part of the otherwise fuscous scutellum (Scudder, 1984). Walley (1929) provided a key to North American species. Lindberg (1958) reported an additional species to the Nearctic fauna, namely *P. distinguendus* (Flor) from Newfoundland, and considered it an introduced element. Subsequently, this species was synonymized with *P. convivus* (Stål) by Putschkov (1969). *Peritrechus convivus* was reported from the Yukon by Scudder (1997), from Alaska by Péricart (1999), and is listed from across Canada in Maw et al. (in press).

In this paper I synonymize *P. saskatchewanensis* Barber with *P. convivus*, describe a new species of *Peritrechus* from western North America, and provide synoptic notes to distinguish the other species in the Nearctic, as the previous original descriptions are not especially diagnostic. A revised key to the North American species of *Peritrechus* is presented. The identity of the Palearctic species *P. oshanini* Kiritshenko is clarified and it is reinstated as a valid species.

Measurements (in millimetres) given are mean and range (in parenthesis) for 10 specimens of each sex, taken from across the range in North America, unless otherwise stated.

Peritrechus convivus (Stål)

Rhyparochromus convivus Stål 1858:180 (orig. descr.)

Pachymerus distinguendus Flor 1860:266 (new species) (syn. by Putschkov 1969)

Trapezonotus convivus, Stål 1862:200 (new combination)

Trapezonotus distinguendus, Fieber 1863:55 (new combination)

Trapezonotus distinctus Douglas & Scott 1863:145 (new species) (syn. by Reuter 1875)

Peritrechus saskatchewanensis Barber 1918:60 (new species) NEW SYNONYMY

Peritrechus distinguendus, Scudder 1957:244 (new combination)

Peritrechus convivus, Scudder 1957:245 (new combination)

Peritrechus convivus, Slater 1964:1251 (bibliogr.)

Peritrechus distinguendus, Slater 1964:1252 (bibliogr.)

Peritrechus saskatchewanensis, Slater 1964:1268 (bibliogr.)

Peritrechus convivus, Péricart 1999:215 (descript., distribution).

Diagnosis. *Dorsum.* Without pale upstanding setae; with short decumbent setae on anterior pronotal disc, base of scutellum and abdominal venter; corium more or less glabrous.

Head. Width ♂ 0.88 (0.85–0.90)¹, ♀ 0.98 (0.92–1.07), vertex width ♂ 0.54 (0.53–0.55), ♀ 0.56 (0.53–0.60); antennae with second and third segments slender and parallel-sided throughout; usually with centre of second and/or third segments flavescent (but see below); antennal measurements ♂ 0.27 (0.26–0.28): 0.58 (0.57–0.60): 0.47 (0.45–0.48): 0.65 (0.63–0.67); ♀ 0.29 (0.25–0.33): 0.60 (0.55–0.70): 0.49 (0.43–0.53): 0.73 (0.70–0.74).

Pronotum. Usually at least twice as wide as long; lateral margins convergent anteriorly, mostly straight in middle and with a distinct narrow flange-like carina, this carina usually pale throughout; pronotal length less than width of scutellum; pronotal width ♂ 1.52 (1.47–1.57), ♀ 1.75 (1.60–1.92), pronotal length ♂ 0.76 (0.75–0.77), ♀ 0.83 (0.77–0.93). *Scutellum.* As wide as long, with punctures on apical half not particularly coarse, and not extending onto the flavescent arms of the V-shaped apical mark; scutellar width ♂ 0.94 (0.90–0.97), ♀ 1.10 (1.00–1.23), scutellar length ♂ 0.94 (0.90–0.97), ♀ 1.13 (1.10–1.23).

Total body length. ♂ 4.38 (4.33–4.50), ♀ 4.99 (4.65–5.60).

North American material examined. 2976 specimens. CANADA: Alberta, British Columbia, Manitoba, Newfoundland, New Brunswick, Nova Scotia, Northwest Territories, Ontario, Prince Edward Is., Quebec, Saskatchewan, Yukon. UNITED STATES: Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah. MEXICO: Durango.

Discussion. This is a highly variable species. Specimens from arid areas appear paler and somewhat larger than those from humid areas. Specimens from northern latitudes and higher elevations are somewhat smaller and darker, with the antennal segments completely fuscous, the lateral pronotal carinae darkened, and the membrane more suffused with fuscous. This is true of material I have examined from Alaska and the Yukon. Specimens from over 3,000 m in Mexico are also small and dark.

After collecting specimens in British Columbia between 1959 and 1964, I examined the large collection of *P. convivus* from Russia in the Russian Academy of Sciences in St. Petersburg in 1965. At that time it appeared to me that *P. saskatchewanensis* was the same as *P. convivus*. However, I noted the considerable variation in this species. Between 1966 and 1998, I collected, obtained on loan, and studied material from across North America, and noted a similar size and colour variation. After measuring many hundreds of specimens and dissecting the male genitalia of samples from across the range in the Nearctic, I concluded that only a single, quite variable species was present, and that it was identical to *P. convivus*. Dr. I. M. Kerzhner has kindly compared some North American specimens with Russian material, and agrees that only a single species is involved. He notes (*in litt.*) the high

¹ Measurements based on material from Alberta, British Columbia, Saskatchewan and Colorado.

variability in Palearctic material, with some southern specimens from Siberia and Kazakhstan having most of the second and third antennal segments yellow, and even the first segment more yellow-brown than black, but in some northern specimens all antennal segments are black or dark brown. No differences were found in the structure of the parameres, and the setae on the hind margin of the male genital capsule were variable. Exactly the same situation is found in the North American material. I thus believe only one species is involved and that is naturally Holarctic.

Although Putschkov (1969) reduced *P. oshanini* Kiritschenko to a subspecies of *P. convivus*, this status was queried by Péricart (1999). I find that *P. oshanini* is a distinct species, readily recognized by the setose upper surface. I thus resurrect it to specific status, and thank Dr. Kerzhner for confirming this and allowing me to make this change.

Peritrechus oshanini (Kiritschenko) sp. restor.

Trapezonotus oshanini Kiritschenko 1911:85 (orig. descr.)

Peritrechus oshanini, Scudder 1957:245 (new combination)

Peritrechus convivus oshanini, Putschkov 1969:294 (subspecies status)

Discussion. Péricart (1997) selected a male lectotype for *P. oshanini* from material in the Russian Academy of Sciences in St. Petersburg, with the data: 'Prov. Syrdariensis c. Perovsk, Baigakum pr. Dshulek, 30.v 08, D. Glazunov'. Dr. Kerzhner (*in litt.*) informs me that the type locality is a railway station about 100 km southeast of Kzyl-Orda (formerly Perovsk) in South Kazakhstan. I examined, what are now paralectotype specimens in the University of Helsinki, and in St. Petersburg in March and April 1965, and noted at that time that *P. oshanini* was similar to *P. convivus* in general appearance and coloration. The dorsum, except for the head, was non-shiny, and the second and third antennal segments were slender, parallel-sided, and pale in the middle. Like *P. convivus*, *P. oshanini* had a similar shaped pronotum, with laterally pale flange-like carinae, very evident on the anterior half, but fading out towards the humeral angles. The scutellum was as wide as long, and the tibiae pale. However, the setose dorsum is distinctive and diagnostic.

Peritrechus fraternus Uhler

Peritrechus fraternus Uhler 1871:103 (orig. descr.)

Peritrechus fraternus, Slater 1964:1254 (bibliogr.)

Diagnosis. *Dorsum.* Without pale upstanding setae; with short decumbent setae on anterior pronotal disc, base of scutellum and abdominal venter; corium more or less glabrous.

Head. Width ♂ 0.90² (0.87–0.93), ♀ 0.97 (0.92–1.07); vertex width ♂ 0.53 (0.52–0.57), ♀ 0.56 (0.53–0.60); antennae fuscous, with second and third antennal segments tending to be slender rather than robust and widening distally; antennal measurements ♂ 0.33 (0.30–0.34): 0.61 (0.58–0.67): 0.50 (0.48–0.53): 0.65 (0.60–0.70); ♀ 0.34 (0.33–0.37): 0.68 (0.60–0.73): 0.54 (0.50–0.57): 0.71 (0.67–0.74).

² Measurements based on material from Ontario, Quebec, Idaho and Connecticut.

Pronotum. Distinctly less than twice as wide as long; lateral margins convergent anteriorly, slightly impressed near middle, and usually with distinct lateral pale spots; without a distinct lateral carina; pronotal width ♂ 1.34 (1.25–1.43), ♀ 1.58 (1.45–1.67), pronotal length ♂ 0.78 (0.77–0.80), ♀ 0.85 (0.80–0.90). **Scutellum.** Longer than wide; punctures on apical half of scutellum coarse, and extending onto arms of pale V-shaped apical area; scutellar width ♂ 0.80 (0.77–0.87), ♀ 0.96 (0.83–1.07), scutellar length ♂ 0.99 (0.90–1.07), ♀ 1.12 (1.07–1.23).

Total body length. ♂ 4.31 (3.80–4.85), ♀ 4.89 (4.43–5.30).

Material examined. 402 specimens. CANADA: **British Columbia, Ontario, Quebec.** UNITED STATES: **California, Connecticut, Idaho, Oregon, Utah.**

Discussion. Slater (1964) lists this species from California, Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Massachusetts, Missouri, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, South Dakota, Utah, Lower California, Mexico, Alberta, British Columbia, Ontario and Quebec.

At the present time, I have included all the material from the western United States and British Columbia under *P. fraternus*, although I note that the late P. D. Ashlock in 1958 determined western specimens in the collection of the University of California, Berkeley as a new species.

Walley (1929) separated *P. fraternus* from *P. tristis* by the slender antennae, and relatively wider pronotum. My measurements suggest that the latter character is unreliable. The antennal character is also somewhat variable, but *P. fraternus* does have relatively more slender second and third antennal segments. In eastern specimens the second and third antennal segments are evidently more robust than in western specimens.

Peritrechus paludemaris Barber

Peritrechus paludemaris Barber 1914:516 (orig. descr.)

Peritrechus paludemaris Slater 1964:244 (bibliogr.)

Diagnosis. **Dorsum.** Without pale upstanding setae; with short decumbent setae on anterior pronotal disc, base of scutellum and abdominal venter; corium with minute decumbent setae arising in punctures.

Head. Width ♂ 1.10, ♀ 1.20, vertex width ♂ 0.57, ♀ 0.57; ocelli prominent; antennae fuscous, the second and third segments robust, and thickly setose; second antennal segment slightly thicker apically, antennal measurements ♂ 0.43: 0.77: 0.60: 0.90; ♀ 0.47: 0.83: 0.63: 0.93.

Pronotum. Distinctly less than twice as wide as long; lateral margins convergent anteriorly slightly impressed near middle, and without distinct lateral carina; pronotal length about equal to width of scutellum; pronotal width ♂ 1.82, ♀ 2.03, pronotal length ♂ 1.00, ♀ 1.16. **Scutellum.** Longer than wide; punctures on apical half of scutellum coarse, and extending onto arms of pale V-shaped apical area; scutellar width ♂ 1.10, ♀ 1.17, scutellar length ♂ 1.37, ♀ 1.40.

Total body length. ♂ 5.45, ♀ 6.25.

Material examined. 3 specimens (including holotype). UNITED STATES: **New York.**

Discussion. This species, which is apparently confined to salt marshes in the East (Barber, 1918), is recognizable by its larger size, and lack of lateral pronotal carinae.

***Peritrechus pilosulus*, new species**

Fig. 1

Description. Male. *Dorsum.* With moderately long, dense, erect setae. Mostly dull and appearing frosted, except for head, legs and abdomen which are shiny. *Head.* Black, closely and shallowly punctate; head width 0.90 (0.88–0.93); vertex width 0.49 (0.47–0.50); antennae fuscous, fourth segment often brownish; second and third antennal segments with erect and semi-erect stiff setae, third antennal segment slender, not tapering apically or basally, and not thinner than base of second; antennal measurements 0.35 (0.33–0.37): 0.69 (0.67–0.73): 0.53 (0.50–0.57): 0.75 (0.73–0.80); rostrum reaching posterior coxae. *Pronotum.* Anterior two-thirds black and finely punctate, with area immediately behind head often vaguely pale ferruginous and coarsely punctate; posterior third of disc ochraceous to pale ferruginous, partly suffused with fuscous, and with large fuscous punctures; laterally pronotal disc tending to fuscous throughout and without a distinct pale spot at level of impression; lateral margin without a distinct pale narrow carina anteriorly, but slightly impressed behind middle; pronotal length about equal to width of scutellum; pronotal width 1.31 (1.27–1.38), pronotal length 0.80 (0.77–0.82). *Scutellum.* Fuscous, apical one-fifth with indistinct V-shaped dark ferruginous mark, and without lateral pale impunctate dashes; deeply and coarsely punctate throughout; scutellar width 0.80 (0.77–0.88), scutellar length 0.99 (0.95–1.02). *Hemelytra.* Ochraceous, but suffused with dark brown, especially on apical half of corium; inner half of corium often quite dark; clavus with about 9–14 punctures in single row between two rows of punctures closest to scutellum; corium rather deeply and closely punctate throughout; membrane hyaline and transparent, suffused with brown along corial margin, and between veins in apical half. *Legs.* Femora dark brown to black, with only apex slightly paler, coxae dark brown; fore trochanters flavescent; fore tibiae flavo-ferruginous, middle tibiae brown in basal four-fifths, flavescent apically; hind tibiae brown; fore femora with three larger anterior spines set equidistant along length of ventral field of smaller spines. *Thoracic pleura.* Dull and black; anterior margin of prosternum narrowly ferruginous; posterior margin of metapleura fuscous; coxal lamellae fuscous or at most dark ferruginous, at least at margins. *Abdomen.* Finely, shallowly and densely punctate, and setose. *Total body length.* 4.08 (3.90–4.23).

Description. Female. Colour and structure similar to male. *Measurements.* Head width 0.95 (0.87–1.00); vertex width 0.54 (0.52–0.57); antennal length 0.31 (0.30–0.38): 0.71 (0.63–0.78): 0.55 (0.50–0.60): 0.74 (0.67–0.80); pronotal width 1.41 (1.23–1.50); pronotal length 0.82 (0.73–0.88); scutellar width 0.90 (0.87–1.00), scutellar length 1.09 (1.03–1.20). *Total body length.* 4.45 (3.95–4.75).

Types. Holotype, ♂, UNITED STATES, **California**, Siskiyou Co., Macdoel, 6 mi S, 24.iii.1958, Joe Schuh (OSU). Allotype, ♀, data as holotype (OSU). Paratypes, UNITED STATES, **California**: 15 ♂, 16 ♀, data as holotype (OSU, Scudder Coll.); 1 ♀, id., edge of pond, 29.viii.1961 (OSU); 1 ♂, Siskiyou Co., Koebele Coll. (CAS); 1 ♀, Alameda Co., Koebele Coll. (CAS); 1 ♀, Alameda Co., i.90, Koebele Coll. (CAS); 1 ♂, Centra Costa Co., Alhambra Vall., 29.xii.1905, F. E. Blaisdell (CAS);

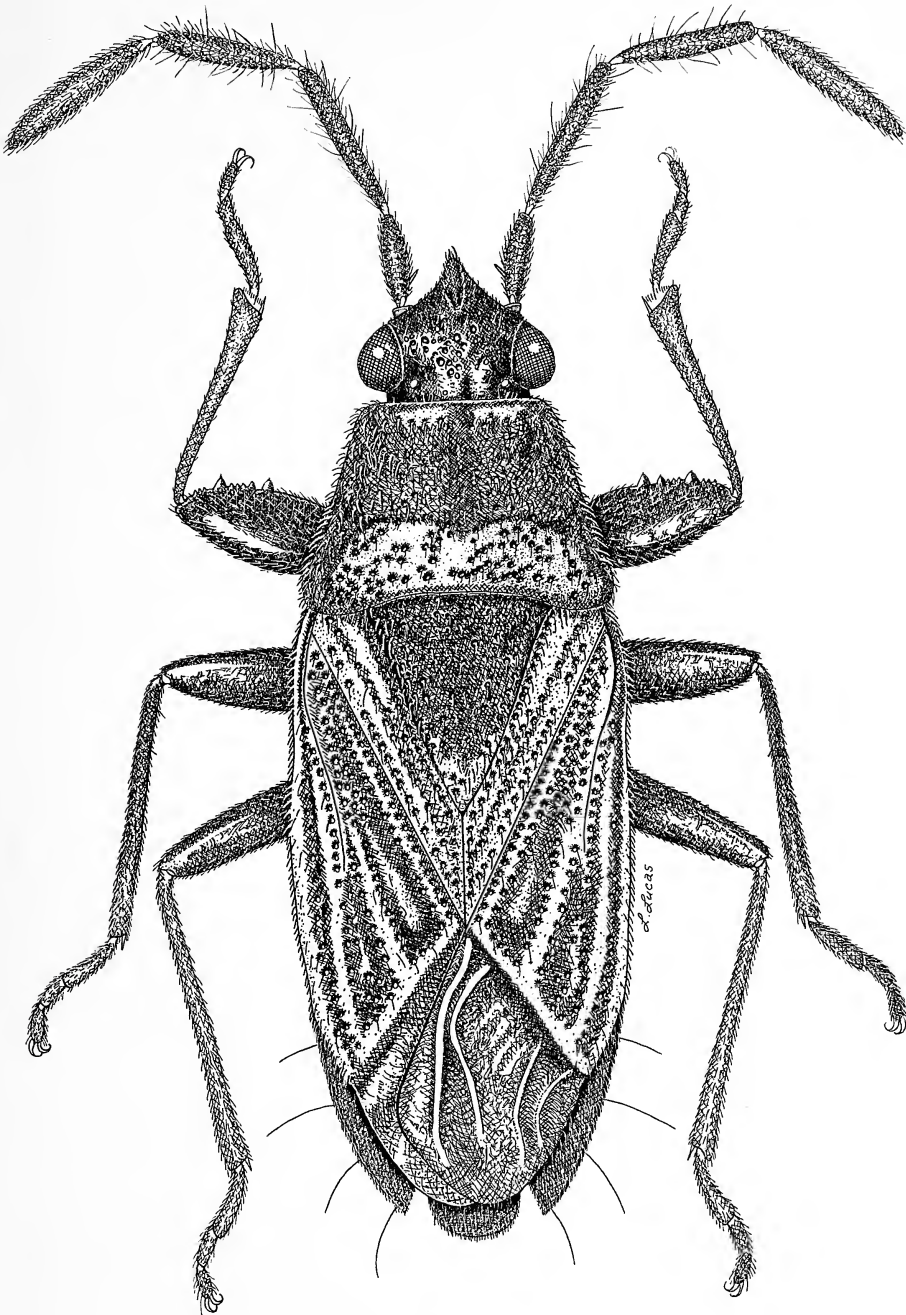


Fig. 1. *Peritrechus pilosulus* Scudder. Dorsal view. Male from USA, California, Siskiyou Co., 6 mi S, Macdoel.

1 ♂, Mt. Diablo Pk., 14.vii.1916, E. P. Van Duzee (CAS); 1 ♀, Oroville, 13.vii.1926, H. H. Keifar (CAS); 1 ♀, San Francisco Co., L. Merced, 19.v.1929, C. L. Fox (CAS); 1 ♀, San Mateo Co., Redwood City, 8.i.1944, P. H. Arnaud (CAS); 1 ♀, Winton, 22.xii.1949, R. P. Allen (UCB); 1 ♀, Colusa Co., Colusa, 15.viii.1955, R. O. Schuster (UCB); 1 ♀, Contra Costa Co., Walnut Cr., foot-Shelf Ridge, fluorescent 15 watt black light, 2.ix.1963, J. Powell (UCB); 2 ♀, Colusa Co., Williams, 6.viii.1964, P. Wells (UCB); 1 ♀, Plumas Co., Feather R., on flower, 4.ix.1970, Douglas Whitman Acc. No. A (UCB); 1 ♀, Sta. Barb. Co., Sta. Cruz Is., Christi Bch., 27.ix.1978, J. Powell (UCB). **Oregon:** 2 ♂, 4 ♀, Klamath Falls, under rock, 20.iv.1958, Joe Schuh (OSU); 1 ♂, Klamath Co., Devil's L., 4.v.1958, Joe Schuh (OSU); 2 ♂, 2 ♀, Klamath Co., Bly, 1 mi S, 4350', on ground, 22.v.1958, J. D. Lattin (OSU); 1 ♀, Klamath Co., Bly Mt., Beatty, 10 mi W, 5000', on ground, 22.v.1958, J. D. Lattin (OSU); 2 ♀, Jackson Co., Pinehurst, ½ mi E, 3350', on ground, 22.v.1958, J. D. Lattin (OSU); 1 ♂, 1 ♀, Wallowa Co., Enterprise, 18 mi N, 4860', roadside under rocks, 27.vi.1960, J. D. Lattin (OSU). **CANADA, British Columbia:** 2 ♀, Osoyoos IRI, 'Brights Winery', 119°32'W 49°13'N, *Purshia* assoc., AN, BGxh, pitfall trap, 6.v-2.vi.1994, G. G. E. Scudder (UBC); 1 ♂, Osoyoos IRI, 'Brights Winery', 119°32'W 49°13'N, *Purshia* assoc., AN, BGxh, pitfall trap, 8.vi-6.vii.1995, G. G. E. Scudder (UBC).

Discussion. *Peritrechus pilosulus* can be distinguished from other North American species of *Peritrechus* by the setose dorsum. It is separated from the Palaearctic *P. oshanini*, which is also dorsally setose, by the lack of carina to the pronotum, the less distinct pale mark on the scutellum, and by having the pronotal length about equal to the width of the scutellum. *Peritrechus oshanini*, like *P. convivus* has the pronotal length shorter than the width of the pronotum.

Most specimens of *P. pilosulus* have the hemelytra reaching to or virtually to the end of the abdomen. However, specimens from British Columbia have distinctly shortened hemelytra reaching only to the middle of tergum VII, and are somewhat smaller than average in total body length. They were collected in pitfall traps set in an antelope-brush (*Purshia tridentata* (Pursh) DC.) community in a bunchgrass eco-zone with a stony-boulder substrate, covered by *Selaginella*.

Peritrechus tristis Van Duzee

Peritrechus tristis Van Duzee 1906:388 (orig. descr.)

Peritrechus tristis, Slater 1964:244 (bibliogr.)

Diagnosis. *Dorsum.* Without pale upstanding setae; with short decumbent setae on anterior pronotal disc, base of scutellum and abdominal venter; corium more or less glabrous.

Head. Width ♂ 0.87 (0.86–0.88), ♀ 0.92 (0.90–0.93); vertex width ♂ 0.51 (0.47–0.53), ♀ 0.54 (0.53–0.55); antennae fuscous, with second and third segments robust, being widest distally, and virtually as thick as fourth segment; antennal measurements ♂ 0.26 (0.23–0.28): 0.53 (0.50–0.57): 0.45 (0.43–0.48): 0.57 (0.53–0.58); ♀ 0.28 (0.27–0.30): 0.57 (0.56–0.58): 0.49 (0.47–0.50): 0.59 (0.58–0.60).

Pronotum. Distinctly less than twice as wide as long; lateral margins convergent anteriorly, slightly impressed near middle, and often without distinct lateral pale

spots; without a distinct lateral carina; pronotal width ♂ 1.26 (1.25–1.27), ♀ 1.37 (1.23–1.47), pronotal length ♂ 0.76 (0.75–0.77), ♀ 0.80 (0.73–0.83); pronotal length about equal to width of scutellum.

Scutellum. Longer than wide; punctures on apical half of scutellum coarse, and extending onto arms of pale V-shaped apical area; scutellar width ♂ 0.73 (0.67–0.77), ♀ 0.79 (0.73–0.83), scutellar length ♂ 0.85 (0.82–0.87), ♀ 0.93 (0.77–1.00).

Total body length. ♂ 3.81 (3.68–3.90), ♀ 4.03 (3.80–4.20).

Material examined. 295 specimens. CANADA: **British Columbia**. UNITED STATES: **California, Oregon**.

Discussion. Best distinguished by the small size and robust second and third antennal segments.

KEY TO NORTH AMERICAN SPECIES OF *PERITRECHUS*

1. Dorsum with dense, rather long, semi-erect pale setae; pale V-shaped mark at apex of scutellum obscure *pilosulus* Scudder
- Dorsum without dense, rather long, semi-erect pale setae; pale V-shaped mark at apex of scutellum usually distinct 2
2. Pronotum with distinct, narrow lateral carinae *convivus* (Stål)
- Pronotum without distinct lateral carinae 3
3. Male over 5.25 mm, female over 6.00 mm in length *paludemaris* Barber
- Male under 5.00 mm, female under 5.5 mm in length 4
4. Third antennal segment slender, parallel-sided and as wide as base of second antennal segment *fraternus* Uhler
- Third antennal segment robust, widest in apical half, and wider than second antennal segment *tristis* Van Duzee

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LITERATURE CITED

- Barber, H. G. 1914. Insects of Florida II. Hemiptera. Bull. Amer. Mus. Nat. Hist. 33:495–535.
 Barber, H. G. 1918. Concerning Lygaeidae — No. 2. J. New York Entomol. Soc. 26:49–66.

- Douglas, J. W. and J. Scott. 1863. *In*: J. Scott (ed.), Additions to the fauna of Great Britain and descriptions of two new species. Ent. Annual 1863:139-146.
- Fieber, F. X. 1863. Erörterungen zur Nomenclatur der Rhynchoten (Hemiptera), Livland's Wien. Ent. Meschr. 7:53-62.
- Flor, G. 1860. Die Rhynchoten Livlands in systematischer Folge beschrieben. Arch. Naturk. Liv. Ehst.u.Kurl (2)3-4:1-826.
- Kiritshenko, A. N. 1911. Neue & noch wenig bekannte Hemipteren der russischen Fauna. Rev. Russe Ent. 11:80-95.
- Lindberg, H. 1958. Hemiptera Heteroptera from Newfoundland collected by the Swedish-Finnish expedition of 1949 and 1951. Acta Zoologica Fennica 96:1-25.
- Maw, E., R. G. Foottit, K. G. A. Hamilton, and G. G. E. Scudder. *In press*. Checklist of Hemiptera of Canada and Alaska. NRC Monographs.
- Péricart, J. 1997. Designation de lectotypes et paralectotypes pour des Lygaeidae Paléarctiques et commentaires (Heteroptera) 4. Les types des auteurs russes. Revue Fr. Ent. (N.S.) 19: 123-129.
- Péricart, J. 1999. Hemipteres Lygaeidae euro-mediterraneens, Vol. 3. Systematique: troisieme partie. Faune de France 84C (1998):1-487.
- Putschkov, V. G. 1969. Fauna Ukraine: Lygaeidae. Akad. Nauk. Ukraine, RSR 21:388 pp.
- Reuter, O. M. 1875. Remargues sur le catalogue des Hemipteres d'Europe et du bassin de la Mediterranee par le Dr. A. Puton. Pet. Nouv. Ent. N. 137:547-548.
- Scudder, G. G. E. 1957. The systematic position of *Pachymerus distinguendus* Flor, with a revised key to the British species of *Peritrechus* (Hem., Lygaeidae). Entomol. Monthly. Mag. 93:244-245.
- Scudder, G. G. E. 1984. Two new genera of Rhyparochrominae (Hemiptera: Lygaeidae) from North America. Can. Entomol. 116:1293-1300.
- Scudder, G. G. E. 1997. True bugs (Heteroptera) of the Yukon, pp. 241-336 *in* H. V. Danks and J. A. Downes (eds.), Insects of the Yukon. Biological Survey of Canada (Terrestrial Arthropods), Ottawa.
- Slater, J. A. 1964. A Catalogue of the Lygaeidae of the World. 2 vols. University of Connecticut, Storrs.
- Stål, C. 1858. Beitrag zur Hemipteren-fauna Sibiriens und des Russischen Nord-Amerika. Stettin. Ent. Ztg. 19:175-198.
- Stål, C. 1862. Synopsis Coreidum et Lygaeidum Succiae. Ofvers. Vetensk-Acad. Forh., Stockholm 19:203-225.
- Uhler, P. R. 1871. Notices of some Heteroptera in the collection of Dr. T. W. Harris. Proc. Boston. Soc. Nat. Hist. 14:93-109.
- Van Duzee, E. P. 1906. New North American Heteroptera. Entomol. News 17:384-391.
- Walley, G. S. 1929. Two new species of *Eremocoris* with notes and a key to the species of *Peritrechus* (Hemipt., Lygaeidae). Can. Entomol. 61:41-44.

THREE NEW SPECIES OF *MICRONECTA* FROM THAILAND WITH A KEY TO SE ASIAN SPECIES. (HETEROPTERA: CORIXIDAE)

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Abstract.—Three new species of *Micronecta* are described: *M. drepani* n. sp. and *M. lemnae* n. sp. from Thailand and *M. polhemusi* n. sp. from Thailand and Việt Nam. A key for identification of Micronectinae of Thailand and adjacent areas is presented.

Key words: *Micronecta*, new species, key, SE Asia.

This paper is a preliminary study for a handbook of the Heteroptera of Thailand (Ed. P. P. Chen) of which the first part will deal with aquatic and semiaquatic Heteroptera. The material studied was collected in Thailand for this project by P. Chen, N. Nieser (NCTN) and H. Zettel (NHMW). Additional material from adjacent areas in NHMW has also been studied. New records are based on specimens in these two collections.

Measurements are given in mm and are based on 5♂ and 5♀ from the series containing the holotype, if available. They are presented as the mean followed by the sample standard deviation (square root of sum of quadrates divided by $N-1$), if N is different from 5 this is mentioned. For some measurements the value of the holotype is given in *italics* between brackets behind the standard deviation.

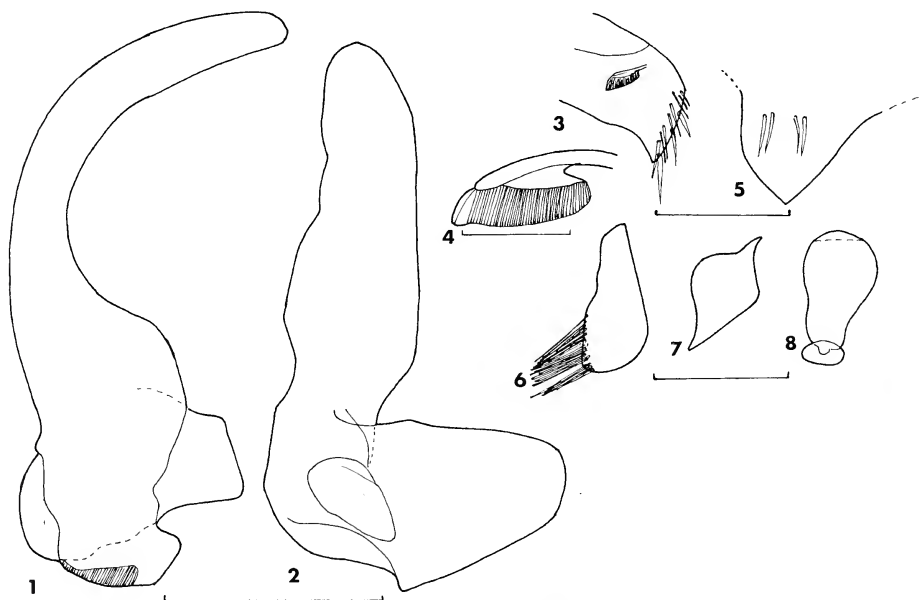
Length without specification is the body length measured from apex of head to apex of hemelytra in dorsal view.

A special ratio is the ocular index, which is calculated as two times the synthlipsis divided by the width of the head across the eyes minus the synthlipsis.

Micronecta is the type genus of the subfamily Micronectinae of the family Corixidae. The subfamily consists of small to very small (body length 0.8–6 mm) Neopomorpha with greatest species diversity in tropical areas (Hungerford, 1958; Wróblewski, 1968; Nieser, 1977). Especially in *Micronecta*, species from warmer areas tend to be predominantly macropterous whereas in temperate regions the brachypterous form is usually more common (Wróblewski, 1958). Micronectinae can be very numerous in suitable habitats thus forming in several instances an important element in the food chain.

SYSTEMATICS

The subfamily Micronectinae contains three genera: *Micronecta* Kirkaldy, 1897; *Synaptonecta* Lundblad, 1933; *Tenagobia* Bergroth, 1899. The latter is restricted to the Americas and was until recently the only genus represented there (Nieser, 1977). *Micronecta* is widespread in all major regions of the Old World. *Synaptonecta* with only two species (Wróblewski, 1972) has its original distribution from India and Sri Lanka through SE Asia to Java. However, in the meantime *Synaptonecta issa* Distant



Figs. 1-8. *Micronecta drepani* sp. n. paratypes, 1-7 ♂; 8 ♀: 1. Right paramere, 2. Left paramere, 3. Right part of tergite 6, 4. Strigil, 5. Median lobe of sternite 7, 6. Free lobe of left part of tergite 8, 7. Prestrigilar lobe, 8. Receptaculum seminis. Scales: 4 0.05 mm; 1, 2 0.1 mm; 3, 5-8 0.25 mm.

has established itself in Florida (Polhemus and Rutter, 1997) and has turned up in an aquarium in New Zealand (Jansson and Meyer-Rochow, 1990). *Micronectella* Lundblad (1933) and *Mesonecta* Poisson (1938) are currently considered subgenera of *Micronecta*. As the assignment of some species to subgenera is uncertain and a thorough analysis of the entire genus to establish subgeneric species groups is needed, subgenera are not used in this paper.

The Micronectine fauna of continental SE Asia has so far been little studied. Wróblewski (1968) gives a checklist of Oriental species. The fauna of India and Sri Lanka, containing a considerable number of species occurring also in SE Asia, has been treated by Hutchinson (1940) and Wróblewski (1972); the fauna of Viêt Nam has been treated by Wróblewski (1962, 1967); Nieser & Chen (1999) provide a key to the fauna of the western part of Indonesia complementing the classical work by Lundblad (1933) for this area.

***Micronecta drepani*, new species**

Figs. 1-10

Description. Macropterous form (based on specimens glued on carton). *Dimensions.* Length ♂ 1.98, s 0.053 (2.10), ♀ 2.08, 0.088; width ♂ 1.01, 0.042 (1.05), ♀ 1.06, 0.046; width of head ♂ 0.76, 0.026 (0.78), ♀ 0.80, 0.021; synthlipsis ♂ 0.38, 0.007 (0.40), ♀ 0.39, 0.012; width of an eye ♂ 0.21, 0.008 (0.21), ♀ 0.23, 0.011; width of pronotum ♂ 0.82, 0.023 (0.83), ♀ 0.85, 0.038.



Figs. 9–10. *Micronecta drepani* n. sp. paratype, 9. Fore leg, 10. Pala. Scales: 9, 0.25 mm; 10, 0.1 mm.

Color. Dorsally generally medium brown, head yellowish except for the grey eyes. Hemelytra with ill defined lighter and darker patches, basally (in the area where most species have a V-shaped hyaline stripe) and along costal margin red; surface of hemelytra with rather evenly scattered distinct pale spine-like bristles, hyaline stripes at base of clavus and inner side of right membrane absent; embolium basally with a dull black spot. Hind wings hyaline with a light smoky brown tinge. Venter dark, legs yellowish with apex of middle tarsus and posterior claw dark.

Ratio length/width of body, ♂ 1.96, 0.071, ♀ 1.96, 0.110. Head slightly narrower than pronotum, synthlipsis over 1.5 times wider than posterior width of an eye, ocular index ♂ 2.00, 0.073, ♀ 1.92, 0.091. Pronotum dorsally distinctly convex, about two and a half times as wide as long (W/L ♂, ♀ 2.4). Spines laterally on abdominal segments: IV and V one short, one long; VI two short, two long, VII four short, three longer; VIII five short, two apically very long, hair-like. Submarginal row of bristles on right side of tergite 5 absent, only some small bristles of the same size as those covering the rest of the surface of the tergite present. Leg measurements summarized in Table 1.

Male, fore leg (Fig. 9); femur with a pair of spine-like bristles in basal third, an apical pair and a single slightly larger one subapically. Tibia with three subapical spine-like bristles ventrally, dorsally of these a thinner, hair-like, bristle and on dorsal margin a pair of longer hair-like bristles (Fig. 10). Pala (Fig. 10) with two shorter proximal and three long distal dorsal hairs, palm with 13–17 bristles in dorsal and 16–20 in ventral row, the ventral palmar bristles much more strongly developed than the dorsal ones, apically a thick bristle suggesting a secondary claw; claw large, very broadly truncate apically, without ventral notch, resembling a trowel. Abdomen, lobes of abdominal tergite 4 with nine to twelve bristles each. Prestigilar flap distinct (Fig. 7), strigil small, oval, 1 comb with about 50 elongate teeth which are so tightly packed that they are difficult to count (Figs. 3, 4). Median lobe of seventh abdominal sternite with a relatively short and broad, pointed caudal part and four larger bristles at base (Fig. 5). Free lobe of left part of segment 8 nearly rectangular, lateral point ill defined, with a row of 18–22 bristles along lateral margin (Fig. 6). Plectrum on right part of segment 8 with very shallow indistinct ribs somewhat like a fingerprint, about 15 submarginal hairs in one row along inner margin between plectrum and

Table 1. Mean value of leg measurements* of *Micronecta* in mm.

	Femur	Tibia	Tars1	Tars2	Claw
<i>M. drepani</i>					
fore leg ♂	0.26	0.14	0.15		
fore leg ♀	0.26	0.25			
middle leg	0.63	0.22	0.33	—	0.19
hind leg	0.45	0.37	0.39	0.17	0.13
<i>M. lemnae</i>					
fore leg ♂	0.194	0.075	0.100		
fore leg ♀	0.185	0.178			
middle leg	0.47	0.173	0.202	—	0.131
hind leg	0.27	0.21	0.196	0.123	0.088
<i>M. polhemusi</i>					
fore leg ♂	0.33	0.19	0.16	—	—
fore leg ♀	0.37	0.36	—	—	—
middle leg	0.78	0.27	0.36	—	0.17
hind leg	0.51	0.46	0.49	0.20	0.12

* The measurement of the fore tibia in the ♀ refers to the joint tibia and tarsus.

apex of right part of segment 8. Right paramere (Fig. 1) with a distinct bulge at base of shaft, shaft evenly and strongly curved, about 35 ribs on pars stridens process. Left paramere comparatively large with a broad and flat apical part (Fig. 2). Aedeagus without special features.

Female fore leg, with essentially the same pattern of spines as in male. The three apical tibial spines indicate the border between tibia and pala on the tibiopala, claw narrow, sharply pointed, secondary claw present. Receptaculum seminis (fig. 8) quite small, simple, urn-shaped.

Types. Holotype, macropterous ♂, THAILAND, **Mae Hong Song Prov.**, Phaa Bong (about 20 km S of Mae Hong Song, along the road), small pond at base of water fall, most *Micronecta* collected between gravel and pebbles at outlet of pond and beginning of continuation of streamlet, N9511, 12.xi.1995, leg. N. Nieser (NCTN). Paratypes, THAILAND, **Mae Hong Song Prov.**, same data as holotype: 1♂, 3♀ (including allotype); same locality and date as holotype, leg. H. Zettel (13e), 12♂, 16♀ (NHMW). Phaa Bong, further down the stream at first crossing with path, N9512, 12.xi.1995, leg. N. Nieser 1♂, 1♀ (NCTN). **Phetchabun Prov.**, Nam Nao N.P., Huai Phrom Laeng, 24.xi.1995, leg. H. Zettel, 4♂, 20♀; Nam Nao N.P., Phrom Laeng, 22.iii.1994, leg. W. D. Shepard, 1♂, 3♀ (NHMW). All macropterous.

Etymology. Drepani (Greek: sickle), noun in apposition referring to the shape of the right paramere.

Discussion. In view of the shape of the left paramere, the large apically widened palar claw in the male, and the reduction of the submarginal row of bristles on the right side of tergite 5 of the male this species belongs to subgenus *Micronecta* s. str. (Hutchinson, 1940). The strongly and evenly curved right paramere is diagnostic; other species with a similar left paramere have the right paramere nearly straight or

hooked apically. The palar claw of the male is larger than in most species; its trowel-like shape and the reddish colour at the base and costal margin of the hemelytra is diagnostic compared to other *Micronecta*.

***Micronecta lemnae*, new species**

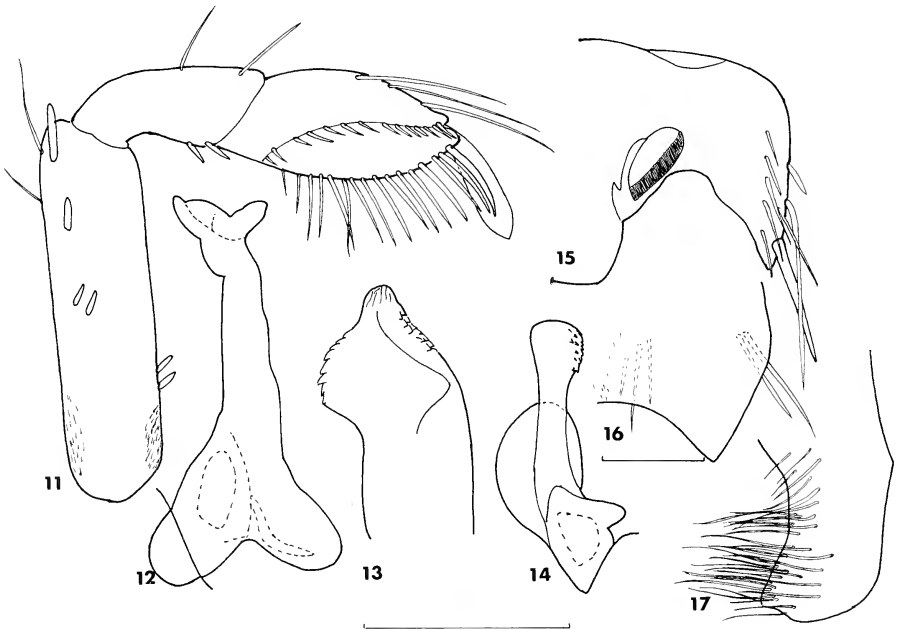
Figs. 18–27

Description. Brachypterous form (based on alcohol specimens and the ♀ from NHMW glued to a carton). *Dimensions.* Length ♂ 1.26, ♀ 1.29, s 0.043; width ♂ 0.71, ♀ 0.77, 0.026; width of head ♂ 0.52, ♀ 0.55, 0.017; synthlipsis ♂ 0.24, ♀ 0.25, 0.015; width of an eye ♂ 0.15, ♀ 0.16, 0.006; width of pronotum ♂ 0.44, ♀ 0.45, 0.025.

Color. Dorsally sordid pale yellow, eyes castaneous, frons pale yellow, rostrum brown. Hemelytra smooth, with relatively large, usually poorly contrasting (most distinctly in the NHMW specimen), brown patches, a pair along each costal margin most distinct; hyaline mark at base of clavus very broad, not V-shaped. Venter, legs and dorsum of abdomen sordid yellow, some small crimson dots around the openings of the dorsal glands of the allotype which have developed into brown patches in the other specimens.

Ratio length/width of body ♂ 1.77, ♀ 1.67, 0.036. Head distinctly wider than pronotum, caudolateral angles of eyes covering the sides of pronotum and reaching the anterolateral angles of the hemelytra, synthlipsis slightly over 1.5 as wide as posterior width of an eye (0.24/0.16), ocular index ♂ 1.72, ♀ 1.71, 0.129. Pronotum distinctly reduced, flat, four and a half times as wide as long (W/L ♂ ♀ 0.45/0.10). Spines laterally on abdominal segments: VI two short, two long; VII two to three short, two to three long; VIII five short, one longer and two apically long hair-like. Submarginal row of bristles on right side of tergite 5 consisting of four evenly spaced bristles. Leg measurements summarized in Table 1.

Male, fore leg (Fig. 11); femur along ventral margin in basal third with a pair of spines, another pair halfway and two spines in apical third where there are a few hair-like bristles along dorsal margin. Tibia with two spine-like bristles ventrally and in the apical part and two more hair-like ones along dorsal margin. Pala with 3 elongate dorsal bristles, palm with 14 bristles in dorsal and 16 in ventral row, claw a simple wide elongate flap. Prestrigilar flap poorly differentiated; strigil (Fig. 15) small, elongate oval, 1 comb with about 80 elongate teeth, which are very densely packed and difficult to count. Median lobe of seventh abdominal sternite with a short and broad, pointed caudal part and two strongly and three relatively more weakly developed, larger bristles (Fig. 16), however, the microscopical slide is indistinct in this part, notably the two large bristles may turn out to belong to another part of the segment. Free lobe of left part of segment 8 with caudal margin curved on the medial side and somewhat pointed laterally (Fig. 17); lateral half with 32 bristles; left part of segment laterally with a dense fringe of rather long hairs of which the larger ones in apical part are warted or serrate along their convex margin. Plectrum on right part of segment 8 apparently absent, seven submarginal hairs in one row along inner margin in apical half of apex of right part of segment 8. Right paramere (Fig. 12)



Figs. 11–17. *Micronecta lemnae* n. sp. holotype ♂: 11. Fore leg, 12. Right paramere, 13. Apex of aedeagus, 14. Left paramere, 15. Right part of tergite 6 with strigil, 16. Median lobe of sternite 7, 17. Free lobe of left part of tergite 8. Scales: 0.1 mm.

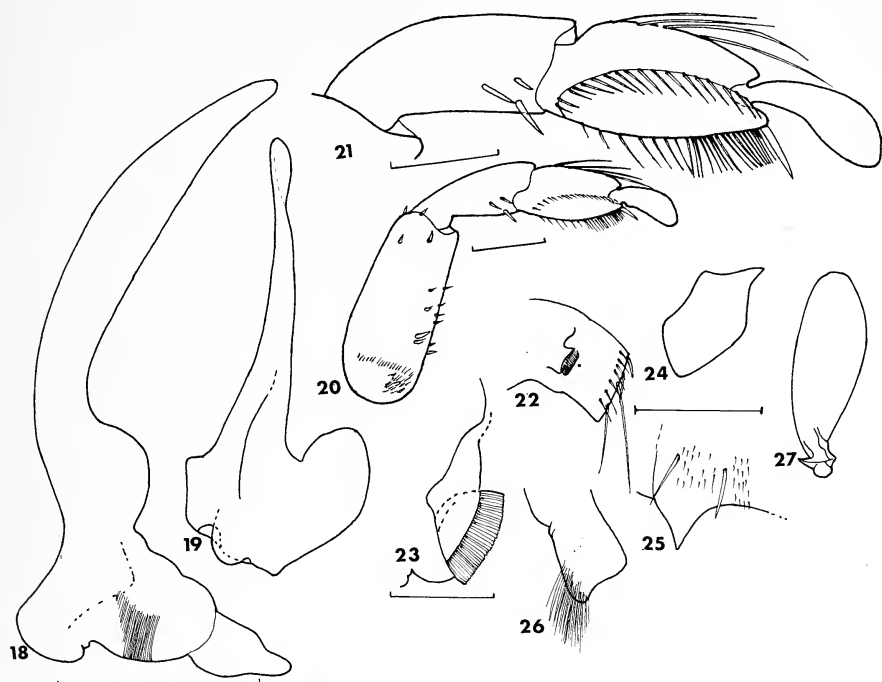
with a widened, lobed apex, pars stridens process not apparent. Left paramere clavate (Fig. 14), apex scaly. Aedeagus with two large teeth or flanges (Fig. 13).

Female. Anterior leg with the same pattern of spines and bristles as the male, claw normal, elongate and pointed. Tergite 8 lacking the thick fringe of bristles on its left side. Receptaculum seminis simple, urn-shaped.

Types. Holotype, ♂, brachypterous, THAILAND, **Phitsanulok Prov.**, Khao Pue-ya, 148 km E. of Phitsanulok City, upper part of Khak stream, subdivision of Tung Sa Kang Luang National Park, 24.xi.1994, leg. P. Chen & S. Piyapichart (NCTN). Paratypes, THAILAND, **Phitsanulok Prov.**: 1 ♀, same data as holotype (NCTN); **Mae Hong Song Prov.**, 11.xi.1995, km 17N Mae Hong Song, stream along road to Pha Sua waterfall (near “fish cave”), quiet bay with slightly muddy sand bottom, N9509, leg. N. Nieser, 1♀ (NCTN); Mae Hong Song River & dam, 3 km SE Mae Hong Song, 13.xi.1995, leg. H. Zettel, 1♀ (NHMW). All brachypterous.

Etymology. The species is named after my colleague Dr. Ping Ping Chen who collected the type series and wrote several important contributions to the knowledge of Asian Gerromorpha. The Chinese characters “ping ping” mean duckweed.

Discussion. Closely related to *M. pumilio* Lundblad (1933) from Java which is, however, still smaller with a body length of 0.8 mm and has the shaft of the left paramere narrower and its apex not clavate, right paramere and free lobe of tergite 8 differ only in details. The right paramere of these two species differs from all other *Micronecta* known. They also do not fit in any of the described subgenera.



Figs. 18–27. *Micronecta polhemusi* n. sp. paratypes, 18–26 ♂, 27 ♀: 18. Right paramere, 19. Left paramere, 20. Fore leg, 21. Fore tibia and pala, 22. Right part of tergite 6, 23. Strigil, 24. Prestigilar lobe, 25. Median lobe of sternite 7, 26. Free lobe of left part of tergite 8, 27. Receptaculum seminis. Scales: 23 0.05 mm; 18, 19, 21 0.1 mm, 20, 22–27 0.25 mm.

Micronecta polhemusi, new species

Figs. 18–27

Description. Macropterous form (based on specimens glued on carton and alcohol specimens). *Dimensions.* Length, ♂ 2.57, s 0.098 (2.40), ♀ 2.70, 0.046; width ♂ 1.17, 0.054 (1.10), ♀ 1.20, 0.068; width of head ♂ 0.92, 0.032 (0.86), ♀ 0.94, 0.033; synthipsis ♂ 0.45, 0.031 (0.40), ♀ 0.46, 0.033; width of an eye ♂ 0.26, 0.030 (0.23), ♀ 0.28, 0.009; width of pronotum ♂ 0.97, 0.041 (0.90), ♀ 1.02, 0.043.

Color. Dorsally generally dark grey, interoculus light brown, eyes grey, frons with a distinct castaneous mark extending onto clypeus and rostrum. Scutellum reddish brown. Hemelytra grey with distinct pale spine-like bristles in rather regular longitudinal rows, margins of clavus lighter, hyaline stripes at base of clavus and inner side of right membrane as usual in genus; embolium and an ill-defined broad transverse band on corium darker brown, darker pattern well visible with light shining through hemelytra only. Inner half of right membrane and outer half of left membrane smoky brown opaque, inner half of left membrane hyaline. Hind wings hyaline with slightly infuscated tips. Venter brown, legs yellowish brown with apex of middle tarsus and posterior claw dark, pala of male with a distinct brown patch covering most of posterior surface less developed in female, anterior claw brown.

Ratio length/width of body ♂ 2.19, 0.070, ♀ 2.27, 0.100. Head slightly narrower than pronotum, synthlipsis about 1.5 times wider than posterior width of an eye, ocular index ♂ 1.99, 0.087, ♀ 1.97, 0.068. Pronotum dorsally distinctly convex, about two and a half times as wide as long (W/L ♂ 2.3–2.5, ♀ 2.2–2.7). Spines laterally on abdominal segments: IV and V three or four short, one long; VI and VII three or four short, two longer; VIII four short, two apically very long. Submarginal row of bristles on right side of tergite 5 consisting of five to nine bristles evenly spaced over the length of the tergite. Leg measurements summarized in Table 1.

Male, fore leg (Fig. 20); femur with a row of about nine smaller spine-like bristles along ventral margin, a row of four slightly larger bristles just dorsally of the ventral margin, a pair of subapical and an apical pair of small bristles in dorsal half; tibia with three subapical spine-like bristles ventrally. Pala (Fig. 21) with 4–5 long dorsal hairs, palm with 14–18 bristles in dorsal and about 23 in ventral row, apically a thick bristle suggesting a secondary claw, claw broadly clavate, without ventral notch. Abdomen, lobes of abdominal tergite 4 with four median and two slightly smaller lateral bristles each. Prestrigilar flap as in Fig. 24; strigil small, oval, one comb with about 50 elongate teeth which are so tightly packed anteriorly that they are difficult to count (Figs. 22, 23), median lobe of seventh abdominal sternite with a relatively short and broad, pointed caudal part and two larger bristles at base (Fig. 25). Free lobe of left part of segment 8 with a lateral point with a tuft of 16–23 bristles (Fig. 26). Plectrum on right part of segment 8 with very shallow indistinct ribs somewhat like a finger-print, about eight submarginal hairs in one row along inner margin between plectrum and apex of right part of segment 8. Right paramere (Fig. 18) with a distinct bulge at base of shaft, 24–28 ribs on pars stridens process. Left paramere with a slightly twisted apex (Fig. 19). Aedeagus without special features.

Female fore leg, with essentially the same pattern of spines as in male. The three apical tibial spines indicates the border between tibia and pala on the tibiopala, claw narrow, sharply pointed, secondary claw present. Receptaculum seminis (Fig. 27) quite large, simple, clavate.

Types. Holotype, macropterous ♂, THAILAND, **Phitsanulok Prov.**, 110 km E of Phitsanulok City, Tung Saleang Luang N.P., stream, 300 m, 17.xi.1994, leg. P. P. Chen & S. Piyapichart (NCTN). Paratypes THAILAND, **Phitsanulok Prov.**: same data as holotype, 2♂, 3♀ (including allotype, NCTN, 1♂ on 4 microscopic slides). **Khon Kaen Prov.**, Noon Hua Chang, open area with small dam, rockpools & small potholes, N9523, 21.xi.1995, 1♂ (NCTN). VIÊT NAM: Nam Cat Tien N.P., 1–16.vi.1994, leg. P. Pacholátka & L. Dembicky (NHMW) 5♂, 7♀. All macropterous. **Etymology.** Named after Dr. J. T. Polhemus for his many contributions to the knowledge of aquatic and semiaquatic bugs.

Discussion. Related to *M. khasiensis* and *M. waltoniana* both described from Assam by Hutchinson (1940) and placed by him in the subgenus *Mesonecta* Poisson, which is characterized by the secondary claw of the male pala. Both these species lack the distinct castaneous frontal mark. The size of *M. polhemusi* is intermediate between the above mentioned. The right parameres of both *M. khasiensis* and *M. waltoniana* lack the bulge at the base of the shaft. The anterior femur of *M. khasiensis* lacks the ventral row of spines. *Micronecta waltoniana* has a ventral row of bristles on the fore femur but has a narrow, not clavate claw in the male. All three species have a

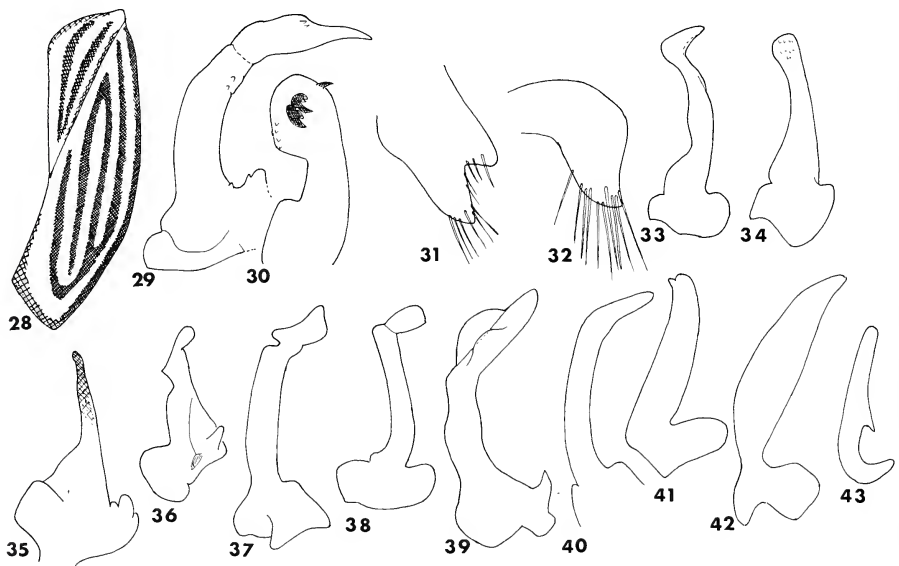
similar number of bristles along the palm. The only other species in this subgenus, *M. pilosa* Poisson (1938) from Madagascar, is much larger, body length 4 mm, and has the free lobe of tergite 8 in the male narrower, apically evenly rounded, and with seven apical bristles only.

KEY TO MICRONECTINAE OF THAILAND AND ADJACENT AREAS
In many cases only ♂♂ identifiable

As some new records and undescribed species are still to be expected in the area, users of the key below who come across material which clearly does not run in the key are kindly requested to send it for study to N. Nieser, Htg. Eduardstr. 16, 4001 Rg Tiel, The Netherlands. Alcohol samples are much easier to deal with than dry prepared specimens.

Abbreviations. A = Assam; B = Myanmar; C = SW China; I = Indonesia; L = Laos & Cambodia; M = West Malaysia (including Singapore); S = Sumatra; T = Thailand; V = Viêt-Nam; W = widespread; ! first record; * known distribution restricted to this country.

- 1. Vertex with a round impression, surface of hemelytra with a scaly microstructure, fore tibia and pala fused in both sexes [W] *Synaptonecta issa* (Distant).
 - Vertex convex or, rarely, flattened, surface of hemelytra smooth, fore tibia and pala in males separate (Figs. 9, 10) (*Micronecta*) 2
- 2. Dark pattern of hemelytra punctuate, large species, length 2.6–3.3 mm [W]
 - *M. haliploides* Horváth.
 - Dark pattern of hemelytra not punctuate, usually with more or less well defined stripes or reticulate, in some species hardly any pattern except for the hyaline strips at base of clavus and inner margin of right membrane, length 1.3–4.0 mm 3
- 3. Dark pattern on corium consisting of four distinct solid, regular parallel bands (Fig. 28) 4
 - Dark pattern on corium streaky, irregularly linear or indistinct 5
- 4. Larger species, length 2.8–3.4 mm, pronotum with a distinct dark transverse stripe in the middle [W, T!] *M. siva* (Kirkaldy).
 - Smaller species, length 1.9–2.3 mm, pronotum with a subovally curved darker stripe on each side (“spectacles frame” of Wróblewski, 1968, 1972) which may be indistinct or fragmented, no transverse stripe [India, Sri Lanka, T!]
 - *M. ludibunda langkana* Wróblewski.
- 5. Males: right paramere apically with an acute projection (Fig. 29) aedeagus in addition to the normally present small teeth with a few large hooks. Length 2.1–2.5 mm. (Fig. 30) [T!, V] *M. jacezewskii* Wróblewski.
 - Male: right paramere with a less strongly narrowed tip, aedeagus with small teeth only. Length 1.3–4.0 mm 6
- 6. Length 2.4 mm or more 7
 - Length less than 2.4 mm 12
- 7. Length 3.5 mm or more [W] *M. scutellaris* (Stål).
 - Length up to 3.3 mm 8
- 8. Longitudinal stripes on corium hardly discernible, males with or without a strigil 9
 - Corium with distinct stripes, which may be interrupted, on lighter background, males with a strigil 10
- 9. Colour very dark, lateral margins of pronotum half as long as median length of pronotum (0.2/0.4), width of pronotum 2½ times its median length (1.0/0.4), males with



Figs. 28-43. Semidiagrammatical drawings of structural details in *Micronecta* males. 28. *M. siva* Kirkaldy right hemelytron; 29-30. *M. jaczewskii* Wróblewski right paramere and aedeagus (after Wróblewski, 1962); 31, 32 Free lobe of left part of eighth tergite; 31. *M. grisea* (Fieber), 32. *M. quadristrigata* Breddin; 33-36, 38, 41 Left paramere, 37, 39, 40, 42 Right paramere; 33. *M. quadristrigata* Breddin, 34. *M. sedula* Horváth, 35. *M. fugitans* Breddin, 36. *M. johorensis* Fernando (after Fernando, 1964), 37. *M. pocsi* Wróblewski (after Wróblewski, 1967), 38. *M. ludibunda* Breddin, 39. *M. guttatostrigata* Lundblad, 40-41. *M. anatolica* Lindberg, 42. *M. fulva* Paiva (after Hutchinson 1940); 43. *M. tarsalis* Chen, tarsal claw.

- a strigil, free lobe of left part of tergite 8 with a sinuate distal margin (Fig. 26), length 2.4-2.8 mm [T!, V!] *M. polhemusi* n.sp.
- Colour light to medium brownish grey, lateral margins of pronotum one third as long as median length of pronotum (0.1/0.3), width of pronotum three times its median length (1.0/0.3), males without a strigil, free lobe of left part of tergite 8 with a deeply incised distal margin resulting in a short fingerlike projection usually pointing medially (Fig. 31), length 2.6-3.1 mm [W, T!] *M. grisea* (Fieber) (= *thyesta* Distant, Wróblewski, 1968).
10. Male, sternite 7 (in the middle) with two large setae, body length 2.8-2.9 mm [India, V] *M. desertana* Distant.
- Male, sternite 7 with four, sometimes weakly developed, bristles, body length 1.2-3.4 mm 11
11. Male, free lobe of 8th abdominal tergite sigmoid (Fig. 32), tip of left paramere sickle-shaped (Fig. 33), body length 2.2-2.9 mm [W, T!] *M. quadristrigata* Breddin.
- Male free lobe of 8th abdominal tergite straight, distal margin slightly sinuate, tip of left paramere truncate to very slightly swollen (Fig. 34), body length 2.9-3.4 mm [Eastern Asia, V] *M. sedula* Horváth.
12. Very small species, length up to 1.3 mm; male, right paramere apically widened with two lobes (Fig. 12) [T!*] *M. lemnae* n.sp.
- Length over 1.5 mm, right paramere different 13

13. Apical part of left paramere rodlike, dark brown (Fig. 35); length 1.8–2.4 mm [T, M, I]	<i>M. fugitans</i> Breddin.
– Apical part of left paramere not brown, length 1.5–2.3 mm	14
14. Right paramere comparatively short & broad, left paramere flattened with two teeth and an apical lobe (Fig. 36); small species, length 1.6–1.8 mm known only in the brachypterous form [M*]	<i>M. johorensis</i> Fernando.
– Parameres different, length 1.5–2.4 mm	15
15. Intermediate claws less than half as long as tibia, specimens from V extremely dark coloured; male apical palar seta thickened suggesting an additional claw; length 2.1–2.3 mm [A, V]	<i>M. khasiensis</i> Hutchinson.
– Intermediate claw relatively longer, three quarters or more the length of tibia, male pala without “additional claw”, length 1.5–2.4 mm	16
16. Right paramere apically with a widened flap-like structure (Fig. 37), length 1.5–1.8 mm [V*]	<i>M. pocsi</i> Wróblewski.
– Tip of right paramere not widened, length 1.7–2.4 mm	17
17. Left paramere with a widened thinner apical lobe (Fig. 38)	18
– Apex of left paramere different	19
18. Hemelytral pattern reticulate, length 2.0–2.3 mm [M*]	<i>M. ludibunda malayana</i> Leong.
– Hemelytral pattern striped, length 1.9–2.2 mm [W] . . .	<i>M. ludibunda ludibunda</i> Breddin.
19. Male lacking a strigil, right paramere apically swollen (Fig. 39); lighter longitudinal lines on corium partly dissolved in small dots, length 2.0–2.4 mm [T!, V, I]	<i>M. guttatostrata</i> Lundblad.
– Male with a strigil, right paramere and hemelytral pattern different, length 1.7–2.2 mm	20
20. Right paramere apically hooked (Fig. 40) or shaft strongly curved (Fig. 1), left paramere with apical part broad (Fig. 2)	21
– Right paramere more or less straight, smoothly curved or sigmoid	22
21. Right paramere strongly curved (Fig. 1), left paramere without small apical tooth, length 1.9–2.2 mm (Fig. 2) [T!*]	<i>M. drepani</i> n. sp.
– Right paramere apically hooked (Fig. 40), left paramere with a small tooth apically (Fig. 41), length 1.6–2.0 mm [W]	<i>M. anatolica</i> Lindberg.
22. Right paramere more or less straight, swollen in the middle (Fig. 42), length 1.9–2.2 mm [B*]	<i>M. fulva</i> Paiva.
– Right paramere curved, length 1.6–2.1 mm	23
23. Costal margin of hemelytra with a simple dark stripe, claw of male pala with a sub-apical tooth (Fig. 43), length 1.6–2.0 mm [I, V]	<i>M. tarsalis</i> L. Chen.
– Costal margin of hemelytra with distinct dark spots (Lbl. 1933: pl. 9 fig. 3), claw of male without subapical tooth, length 1.7–2.1 mm [S, M]	<i>M. decorata</i> Lundblad.

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LITERATURE CITED

Bergroth, E. E. 1899. A new genus of Corixidae. Entomol. Mon. Mag. 35:282.
Chen, L. C. 1960. A study of the genus *Micronecta* of India, Japan, Taiwan and adjacent regions. J. Kansas Ent. Soc. 33:99–118.

- Fernando, C. H. 1964. A new species of *Micronecta* (Hemiptera: Corixidae) from Malaya. Proc. R. Ent. Soc. Lond. (B)33:17-18.
- Hungerford, H. B. 1958. Some interesting aspects of the world distribution and classification of aquatic and semiaquatic Hemiptera. Proc. 10th Int. Congr. Entom. 1956(1):337-348.
- Hutchinson, G. E. 1940. A revision of the Corixidae of India and adjacent regions. Trans. Conn. Ac. Arts Sc. 33:341-476, pls. 1-36.
- Jansson, A. and V. B., Meyer-Rochow. 1990. Sound production in *Synaptonecta issa* (Heteroptera: Corixidae, Micronectinae)—an Asian bug that turned up in a New Zealand aquarium. Appl. Entomol. Zool. 25:328-331.
- Kirkaldy, G. W. 1897. Synonymic notes on aquatic Rhynchota. Entomologist 30:258-260.
- Lundblad, O. 1933. Zur Kenntnis der aquatilen und semiaquatilen Hemipteren von Sumatra, Java und Bali. Arch. Hydrobiol. Suppl. 12:1-195, 263-489, Taf. 1-21.
- Mahner, M. 1993. Systema Cryptoceratorum Phylogeneticum (Insecta, Heteroptera). Zoologica 143:i-ix, 1-302.
- Nieser, N. 1977. A revision of the genus *Tenagobia* Bergroth (Heteroptera: Corixidae). Stud. Neotrop. Fauna Envir. 12:1-856.
- Nieser, N. and P. P. Chen. 1999. Sixteen new species of Nepomorpha mainly from Sulawesi (Indonesia). Tijdschr. Ent. 142:77-123.
- Poisson, R. A. 1938. Les Micronectes de la région Malgache. Rev. Fr. Entomol. 5:135-144.
- Polhemus, J. T. and R. P. Rutter. 1997. *Synaptonecta issa* (Heteroptera: Corixidae), first new world record of an Asian water bug in Florida. Entomol. News 108:300-304.
- Wróblewski, A. 1958. The Polish species of the genus *Micronecta* Kirk. (Heteroptera, Corixidae). Ann. Zool. Polsk. Ak. Nauk 17:247-382.
- Wróblewski, A. 1962. Notes on Micronectinae from Viêt-Nam (Heteroptera, Corixidae). Bull. Ac. Pol. Sc. C1.2 10:175-180.
- Wróblewski, A. 1967. Further notes on Micronectinae from Viêt-Nam (Heteroptera, Corixidae). Polsk. Pismo Ent. 37:229-251.
- Wróblewski, A. 1968. Notes on Oriental Micronectinae (Heteroptera, Corixidae). Polsk. Pismo Ent. 38:753-779.
- Wróblewski, A. 1972. Further notes on Micronectinae from Ceylon (Heteroptera, Corixidae). Polsk. Pismo Ent. 42:1-52, pls. 1-3.

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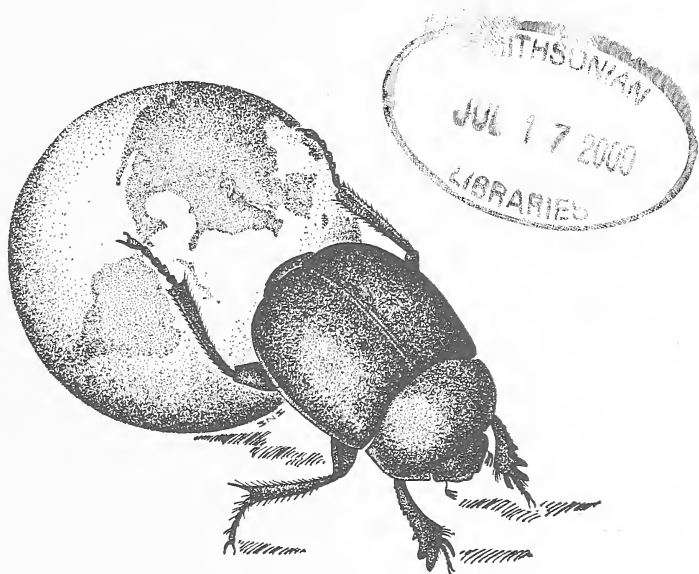
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WATER-SKATING *CAMPSICNEMUS* OF THE MARQUESAS ISLANDS, INCLUDING TWO NEW SPECIES (DIPTERA: DOLICHOPODIDAE)

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Abstract.—Two new species of *Campsicnemus* are proposed from the Marquesas (*C. limnobates* and *C. uncleremus*), which are related to the previously described *Campsicnemus scurra* Parent from Nuku Hiva in the Marquesas. All are water skaters on pools and streamlets. All three species are described and illustrated and a key to the known *Campsicnemus* of the Marquesas is provided.

Key words: Dolichopodidae, *Campsicnemus*, taxonomy, Marquesas.

Dolichopodidae from the Marquesas Islands are not well known. Although the Marquesas represent a tropical island group with many suitable habitats for dolichopodids and harbor an otherwise very diverse insect fauna, only 5 species in 5 genera of dolichopodids have previously been recorded (Bickel and Dyte, 1989; Bickel, 1994): *Chrysosoma tuberculicorne* (Macquart, 1855); *Condylostylus longicorne* (Fabricius, 1775); *Medetera salomonis* Parent, 1941; *Chrysotus denticornis* Lamb, 1932; and *Campsicnemus scurra* Parent, 1934.

Recent collecting efforts on four of the Marquesas islands led by Dan Polhemus (National Museum of Natural History, Washington, D.C.) and Ronald Englund (Bishop Museum) have revealed many new species of *Campsicnemus*, some of which are water skaters on pools. Two new species of water-skating *Campsicnemus* are described here to make the names available for use in upcoming ecological and biogeographical studies of the Marquesan insect fauna.

Parent's (1934) description of *Campsicnemus scurra* from Nuku Hiva in the Marquesan Archipelago was intermixed among descriptions of three new species of *Campsicnemus*, two from the Hawaiian Islands. The presence of *C. scurra* in the Marquesas has been noteworthy, however, in that it represents the only known population of *Campsicnemus* south of the Equator. *Campsicnemus* is primarily a northern temperate genus with a strikingly large number of species from the tropical Hawaiian Islands (est. 300+). Based on the material in hand of numerous undescribed *Campsicnemus* from previous Bishop Museum-sponsored arthropod collecting expeditions to the Marquesas (most recently 1977, 1984, 1988), further investigation of the dolichopodid fauna of the Marquesan islands through rigorous collecting of both aquatic and terrestrial habitats with varied trapping techniques will undoubtedly reveal many more new species of *Campsicnemus* from this area.

MATERIALS AND METHODS

Diagnosis of and key characters in species of *Campsicnemus* are based almost entirely on the male. Females are, for the most part, fairly indistinguishable from

each other and can only be accurately assigned to species on the basis of association with males. Descriptive morphological terminology and associated abbreviations used here follow Bickel (1992) and McAlpine (1981).

Types are deposited either in the National Museum of Natural History, Washington, D.C. (USNM) or Bishop Museum, Honolulu (BPBM) as indicated; with duplicates in the above listed museums plus the Muséum National d'Histoire Naturelle, Paris (MNHN).

Abbreviations used: I, II, III = fore, mid, and hind leg; C = coxa; F = femur; T = tibia; MSSC = male secondary sexual characters; ac = acrostichal setae; dc = dorsocentral setae; np = notopleural setae; oc = ocellar setae; pa = post alar setae; ph = posthumeral setae; sc = scutellar setae; t = tarsus; t1-5 = tarsomeres 1 to 5; vt = vertical setae.

SYSTEMATICS

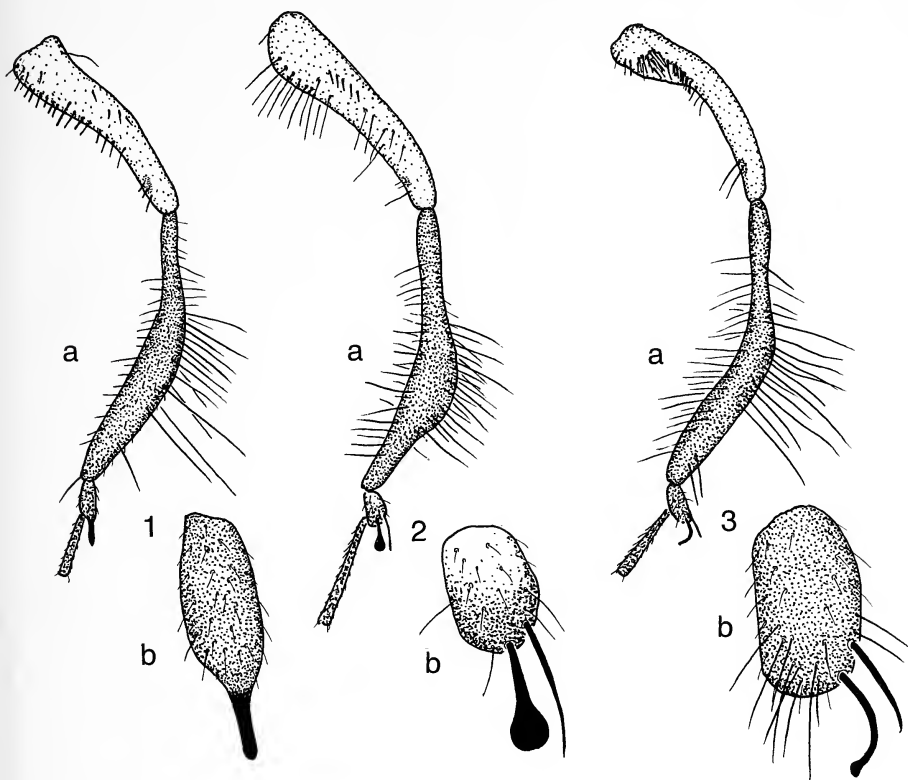
Campsicnemus scurra Parent

Figs. 1, 4

Campsicnemus scurra Parent, 1934:299.

Diagnosis. This species is easily distinguished from the congeners by the combination of a strong tuft of three setae on the fore coxa (because these setae are often tufted together at their tips, Parent misidentified these as a single strong seta); the mid and hind femora possessing long setae and cilia on their apical halves; and IIt1 possessing a single strong apical spur.

Description. *Male.* Body length: 2.11–2.45 mm. Wing length: 2.44–2.69 mm. *Head.* Black, face dark brown to black with reddish highlights, paler brown near clypeus; oc and vt black, about one-third length of antennal arista; front, occiput, and vertex black with blue highlights; face constricted at middle, almost holoptic, eyes separated below antennae by width of 1–2 ommatidia; palp small, dark brown; proboscis brown, extending below eye in lateral view; antennal segments black to brown; first flagellomere long, lanceolate, length about $3.5 \times$ width; arista slightly longer than head height. *Thorax.* Mesoscutum, scutellum, and pleura dark brown to black throughout, with a few metallic greenish highlights laterally; thoracic setae black: 1 + 3 dc; 2 np; 2 ph; 1 pa; 1 + 1 sc; ac absent; halter stem white, knob dark brownish black. *Legs.* CI yellowish white, with apical tuft of three strong black setae, approximate basally, almost fused apically so as to appear as a single strong seta; CII and CIII brown, slightly paler than surrounding pleura; FI and FII yellowish brown, FIII yellowish brown basally, becoming darker brown on apical one-fourth; remainder of legs brown; FI and remainder of foreleg unmodified, without MSSC; FII (Fig. 1a) slightly bowed with strong chetae basally, setae thinner toward apex, with subapical brown patch (sensory area?) harboring two small setae; FIII (Fig. 4) slightly bowed with swollen basal area containing 3–4 medium sized black setae and two long setae more apically, middle of FIII not swollen, containing very long curved, sinuous, and wrinkled setae on ventral surface (MSSC); TiI (Fig. 1a) slightly bowed and swollen medially, with long setae in middle on dorsal surface (MSSC), smaller black setae and hairs along entire ventral surface. TiIII with long hairs basoventrally, dorsal surface with small hairs and only two long setae (one subbasally; the other near

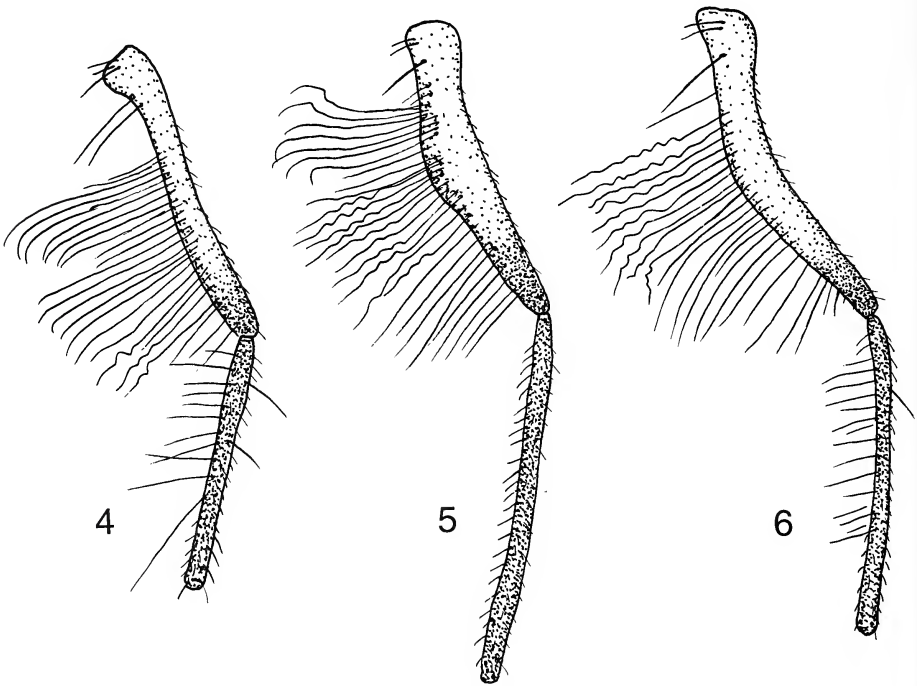


Figs. 1–3. Mid legs of *Campsicnemus* males. 1. *C. scurra* Parent; a, mid femur, tibia, basitarsus, and second tarsal segment; b, detail of basitarsus. 2. *C. limnobates*, n. sp.; a, mid femur, tibia, basitarsus, and second tarsal segment; b, detail of basitarsus. 3. *C. uncleremus*, n. sp.; a, mid femur, tibia, basitarsus, and second tarsal segment; b, detail of basitarsus.

middle) (MSSC). Ilt1 (Fig. 1b) short, about one-half length of Ilt2, with single strong black, blunt apical seta (MSSC). Remainder of leg segments without MSSC. *Wing*. Pale smoky throughout. *Abdomen*. Dark brown with short black hairs dorsally on each tergite, a few longer hairs laterally; tergal interstices whitish; sternites yellowish brown. Hypopygium brown with paler brown cerci, not dissected.

Female. As in male except for lack of MSSC; antennal flagellomere length about $1.5 \times$ width; legs normal, without modifications; FI and FII brown.

Material Examined. FRENCH POLYNESIA, **Marquesas Is.**, Nuku Hiva: 2 ♀, middle Hakaui Valley, 300 ft, on small pool of streamlet tributary to upper midreach, 8°54'46"S, 140°09'52"W, 19.x.1999, R. Englund (BPBM); 10 ♂, 2 ♀, same data except D. A. Polhemus (BPBM, USNM); 2 ♂, 3 ♀, tributary to upper Taipivai River, 1,600 ft, water temp. 21.5°C, 8°52'53"S, 140°07'03"W, on pools, 22.x.1999, D. A. Polhemus (BPBM, USNM); 1 ♂, 8 ♀, Taipi Valley, Tehua Falls, 500 ft, water temp. 23°C, 8°52'14"S, 140°06'16"W, above rocks in rapids, 18.x.1999, D. A. Polhemus (BPBM, USNM); 2 ♂, streamlet crossing road above Taiohae, 1,250 ft, water temp.



Figs. 4–6. Hind femora and tibiae of *Campsicnemus* males. 4. *C. scurra* Parent. 5. *C. limnobates*, n. sp. 6. *C. uncleremus*, n. sp.

23°C, 8°53'21"S, 140°06'25"W, skating on pools, 18.x.1999, D. A. Polhemus (USNM).

Discussion. This water skater is found in many parts of the southern portion of the island of Nuku Hiva on pools associated with a wide variety of streams and at various elevations from 90–490 m (300–1,600 ft).

The indefatigable Evelyn Cheesman collected this species, which Parent (1934) described. Unfortunately, the species was only known from a single male and the data given by Parent “Marquesas Is. Nuka-hiva. St. Georges Exp. L. E. Cheesman (B.M.)” gives no indication of the specific locality on the island where it was captured nor on what date it was collected. The list of Diptera from French Polynesia collected during this expedition was published by Aubertin and Cheesman (1929), but no specific locality data was given for any of the species collected on Marquesan islands during that expedition. Ironically, in a popular book, not specifically directed to scientific audiences, Cheesman (1932) helps somewhat by giving a detailed account of her travels on Nuku Hiva during the St. George Expedition.

The *St. George* landed at two ports (Taipivai and Hakaui) on Nuku Hiva in January 1925 during its stay on that island of only a few days. Cheesman hiked up Taipivai Valley the first day and decided to hike from Taipivai to Hakaui (an 8-hr hike) and met the ship in Hakaui. The next day in Hakaui, she hiked up the Hakaui Valley and climbed the cliffs to the west of Hakaui (about a 1,500-ft climb) anxious to see

the region of the western portion of the island labeled on all the maps she saw as "Le desert." From her 1932 account, it is possible to delimit her capture of the type specimen to pools or streams in Taipi Valley in January 1925. However, without further information, it is impossible to know exactly from which water source in the valley the specimen was collected.

***Campsicnemus limnobates*, new species**

Figs. 2, 5

Diagnosis. This species is easily distinguished from the congeners by the combination of strong tuft of three setae on the fore coxa; the mid and hind femora possessing long setae and cilia on their apical halves; and Ilt1 possessing a single strong spatulate seta apically. It is separated from *C. scurra* and its relatives by the yellow anepisternum (brown in the other species).

Description. *Male.* Body length: 2.15–2.62 mm. Wing length: 2.46–2.89 mm. *Head.* Black, face dark brown to black with reddish highlights, paler brown near clypeus; oc and vt black, about two-thirds length of antennal arista; front, occiput, and vertex black with blue highlights; face constricted at middle, almost holoptic, eyes separated below antennae by width of 1–2 ommatidia; palp small, dark brown; proboscis brown, extending below eye in lateral view; antennal segments black to brown; first flagellomere long, lanceolate, length about $3.5 \times$ width; arista slightly longer than head height. *Thorax.* Mesoscutum, scutellum, dark brown, with a few metallic greenish highlights laterally; pleura dark brown to brown except for yellow on the following sclerites: anepisternum, katapisternum, meron, and anepimeron; katetergite black; thoracic setae black: 4 dc; 2 np; 2 ph; 1 pa; 1 sc; ac absent; halter stem white, knob dark brownish black. *Legs.* CI yellowish white, with apical tuft of three strong black setae, approximate basally, almost fused apically so as to appear as a single strong seta; CII mostly brown, some yellow anteriorly; CIII brown, slightly paler than surrounding pleura; FI and FII yellowish brown, FIII yellowish brown basally, becoming darker brown on apical one-fourth; remainder of legs brown; TiI yellow ventrally, brown dorsally, with long black seta subapically on ventral surface (MSSC); FI and remainder of foreleg unmodified, without MSSC; FII (Fig. 2a) slightly bowed with medium sized setae basally, with subapical brown patch harboring two small setae; FIII (Fig. 5) slightly bowed with swollen basal area containing 2 small black setae and 1 long setae, middle of FIII swollen, containing very long curved (basalmost), wrinkled (medial), and straight (apicalmost) setae on ventral surface (MSSC); TiII (Fig. 2a) slightly bowed and greatly swollen just beyond middle, with long hairs medially on dorsal surface, short hairs along ventral surface (MSSC). TiIII unmodified, without MSSC. Ilt1 (Fig. 2b) yellowish basally, blackish apically, short, about one-third length of Ilt2, with strong black, spatulate apical seta and single associated strong black seta (MSSC). Remainder of leg segments without MSSC. *Wing.* pale smoky throughout. *Abdomen.* Dark brown with short black hairs dorsally on each tergite, a few longer hairs laterally; tergal interstices whitish; sternites yellowish brown. Hypopygium brown with paler brown cerci, not dissected.

Female. As in male except for lack of MSSC; antennal flagellomere length about $1.5 \times$ width; legs normal, without modifications; FI and FII brown.

Types. Holotype, ♂: FRENCH POLYNESIA, *Marquesas Is.*, Ua Huka, Vaiee Cas-

cade on Vaipae River, 700 ft, water temp. 22.5°C, 8°53'52"S, 139°33'17"W, skating on pools, 3.xi.1999, D. A. Polhemus (USNM). Paratypes: FRENCH POLYNESIA, **Marquesas Is.**, Ua Huka: 1 ♂, 5 ♀, same data as holotype (BPBM, USNM); 6 ♂, 2 ♀, Vaihonu Cascade and rocky streams in upper Hane Valley, 500 ft, water temp. 23°C, 8°54'50"S, 139°32'15"W, 1.xi.1999, skating on pools, D. A. Polhemus (BPBM, USNM).

Discussion. This species is a water skater found on pools and streams in the southern portion of the island of Ua Huka at elevations from 150–215 m (500–700 ft).

Etymology. The specific epithet derives from the Greek: λυμνοσ = pool, lake + βατεσ = walker; referring to the water-skating habit of this species.

Campsicnemus uncleremus, new species

Figs. 3, 6

Diagnosis. This species is easily distinguished from the congeners by the combination of strong tuft of three setae on the fore coxa; the mid and hind femora possess long setae and cilia on their apical halves; and IIt1 possesses a single strong apical seta curved 90 degrees.

Description. *Male.* Body length: 2.13–2.35 mm. *Wing length.* 2.45–2.70 mm. *Head.* Black, face dark brown to black with reddish highlights, paler brown near clypeus; oc and vt black, about one-third length of antennal arista; front, occiput, and vertex black with blue highlights; face constricted at middle, almost holoptic, eyes separated below antennae by width of 1–2 ommatidia; palp small, dark brown; proboscis brown, extending below eye in lateral view; antennal segments black to brown; first flagellomere triangular in shape, about 1.5 × width; arista slightly longer than head height. *Thorax.* Mesoscutum, scutellum, dark brown, with a few metallic greenish highlights laterally; pleura dark brown to brown except for yellow on the following sclerites: middle of katapisternum and anepimeron; katetergite black; thoracic setae black: 4 dc; 1 + 1 np; 2 ph; 1 pa; 1 sc; ac absent; halter stem white, knob dark brownish black. *Legs.* CI yellowish white, with apical tuft of three strong black setae, approximate basally, almost fused apically so as to appear as a single strong seta; CII and CIII brown, slightly paler than surrounding pleura; FI and FII yellowish brown, FIII yellowish brown basally, becoming darker brown on apical one-fourth; remainder of legs brown; FI and remainder of foreleg unmodified, without MSSC; FII (Fig. 3a) slightly bowed with strong chetae basally, setae primarily absent apically, with subapical brown patch harboring two long setae; FIII (Fig. 6) bowed with swollen basal area containing 2–3 medium sized black setae and 1 long seta more apically, middle of FIII swollen, containing very long wrinkled (basalmost) and slightly curved and straight (apicalmost) setae on ventral surface (MSSC); TiII (Fig. 3a) slightly bowed and swollen medially, with long setae in middle on dorsal surface (MSSC), black setae and hairs along entire ventral surface, longest just beyond middle of TiII. TiIII with long hairs basoventrally, dorsal surface with small hairs and 1 long seta subbasally (MSSC). IIt1 (Fig. 3b) short, about one-third length of IIt2, with single strong black setae curved 90 degrees and associated strong black seta, (MSSC). Remainder of leg segments without MSSC. *Wing.* Pale smoky throughout. *Abdomen.* Dark brown with short black hairs dorsally on each tergite, a few longer

hairs laterally; tergal interstices whitish; sternites yellowish brown. Hypopygium brown with paler brown cerci, not dissected.

Female. As in male except for lack of MSSC; legs normal, without modifications; FI and FII brown.

Types. Holotype, ♂: FRENCH POLYNESIA, **Marquesas Is.**, Hiva Oa, Taaoa Valley, 600–800 ft, riffle splash zone, 24.x.1999, R. Englund (BPBM 16,209). Paratypes: FRENCH POLYNESIA, **Marquesas Is.**, Hiva Oa: 3 ♂, 3 ♀, same data as holotype (BPBM, USNM); 6 ♂, 1 ♀, Atikua Stream, upper Atuona Valley, 500 ft, water temp. 23.5°C, 9°47'06"S, 139°03'11"W, on stream pools, 24.x.1999, D. A. Polhemus (BPBM, USNM); 13 ♂, 5 ♀, springs and rocky stream at headwaters of east fork of Faakua river, 1,850 ft, water temp. 22°C, 9°45'52"S, 139°59'00"W, skating on stream pools, 25.x.1999, D. A. Polhemus (BPBM, USNM); 4 ♂, 5 ♀, same data except J. T. Polhemus (BPBM, USNM).

Discussion. This species is a water skater found in pools of streams in the southern portion of the island of Hiva Oa at elevations from 150–565 m (500–1,850 ft).

Etymology. Named for the fictional literary character, Uncle Remus, of Afro-American folk tales of the 1880s created by Joel Chandler Harris. The specific epithet is treated here as a noun in apposition.

KEY TO SPECIES OF CAMPSICNEMUS FROM THE MARQUESAS BASED ON MALES

- 1. Pleura entirely brown to black, no yellow present on sclerites; Ilt1 with single strong spur dorsoapically (Fig. 1a) (Nuku Hiva) *scurra* Parent
- Pleura with some yellow on lower sclerites; Ilt1 with more than one modified seta dorsoapically 2
- 2. Anepisternum dark brown to black, no yellow present; Ilt1 with small dorsoapical seta curved 90° and associated strong setae (Fig. 3a) . . (Hiva Oa) . . *uncleremus*, new species
- Anepisternum brown dorsally, yellow ventrally; Ilt1 with strong dorsoapical spatulate setae and associated strong setae (Fig. 2a) (Ua Huka) *limnobates*, new species

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I thank the collectors listed above for making the material available for study. Ron Englund and Dan Polhemus reviewed an early draft of the paper. Specimens from the Marquesas upon which this study was based were obtained in the course of Heteroptera surveys supported by the Smithsonian Institution's Drake Fund.

LITERATURE CITED

Aubertin, D. and L. E. Cheesman. 1929. Diptera of French Oceania. *Entomologist* 62:172–176.

Bickel, D. J. 1992. Sciapodinae, Medeterinae (Insecta: Diptera) with a generic review of the Dolichopodidae. *Fauna N.Z.* 23:69 pp.

Bickel, D. J. 1994. The Australian Sciapodinae (Diptera: Dolichopodidae), with a review of the Oriental and Australasian faunas, and a world conspectus of the subfamily. *Rec. Aust. Mus. Suppl.* 21:394 pp.

Bickel, D. J. & C. E. Dyte. 1989. Family Dolichopodidae, pp. 393–418 in N. L. Evenhuis (ed.), *Catalog of the Diptera of the Australasian and Oceanian Regions*. Bishop Mus. Spec. Publ. 86:1,155 pp.

Cheesman, E. L. 1932. *Hunting insects in the South Seas*. Philip Allan & Co., London. xi + 243 pp.

- McAlpine, J. F. 1981. Morphology and terminology—adults, pp. 9–63 in J. F. McAlpine, B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth and D. M. Wood, (coords.), *Manual of Nearctic Diptera*. Volume 1. Research Branch, Agriculture Canada. Monograph no. 27.
- Parent, O. 1934. *Diptères dolichopodides exotiques*. Mém. Soc. Natl. Sci. Nat. Math. Cherbourg 41:257–308.

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THE BROWN LACEWING GENUS *NOTIOBIELLA* (NEUROPTERA: HEMEROBIIDAE) FROM DOMINICAN AMBER

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Abstract.—*Notiobiella thaumasta*, new species, is described from four specimens preserved in Dominican amber. Probably of mid to early Miocene age, this species appears to be closely related to the extant *Notiobiella* species (particularly *israeli*) that currently occupy Cuba, Hispaniola and the adjacent Central and South American mainland. The specimens reported here are the first hemerobiids to be described in detail from New World amber and are the first reported fossils of the genus *Notiobiella*.

The family Hemerobiidae, brown lacewings, is a cosmopolitan clade (Oswald, 1993) of approximately 550 species (Monserrat, 1990) of small predaceous lacewings belonging to the insect order Neuroptera. Oswald (1993) reviewed the existing literature on fossil hemerobiids, summarized available nomenclatural, taxonomic, and distributional data on fossil hemerobiid species, and compiled published records of fragmentary brown lacewing remains that are identifiable only to the rank of family or genus. Since that time, I have had the opportunity to examine several hemerobiid amber inclusions collected from the Dominican Republic on the Caribbean island of Hispaniola. The Dominican amber insect fauna now includes two described neuropteran species—*Porrerus dominicanus* Poinar and Stange (1996) [Myrmeleontidae] and *Notiobiella thaumasta*, new species [Hemerobiidae, described below]. Additional, undescribed, specimens belonging to the families Ascalaphidae and Chrysopidae (Grimaldi, pers. comm.), Coniopterygidae (Poinar, 1992), Hemerobiidae (a hemerobiine apparently near *Hemerobius* or *Wesmaelius*, specimen in the Poinar Amber Collection; see Poinar, 1992:129, fig. 71) and Mantispidae (Grimaldi, 1996) are also known to exist. The hemerobiid specimens are of special interest as they are the only amber hemerobiids known from outside of the Baltic amber fauna. Together with the British Columbian rock-fossil *Bothromicromus lachlani* Scudder, these specimens constitute the only hemerobiid fossils known from the New World. The purpose of the present paper is to describe the several specimens that collectively constitute the first known fossils of the genus *Notiobiella*, and to place them within the context of our current knowledge of the extant fauna of this genus. For recent reviews of amber origins, sources, stratigraphy, ages and faunas see Anderson and Crelling (1995), Grimaldi (1996), Iturralde-Vinent and MacPhee (1996) and Poinar (1992).

GENUS *NOTIOBIELLA* BANKS

Notiobiella Banks, 1909:80 (Type species [extant]: *Notiobiella unita* Banks, 1909; Australia): Alayo 1968 (review [as *Symphorobius*], Cuba); Monserrat and Penny 1983 (review, some tropical American species); Penny and Monserrat [1985] (re-

view, some tropical American species); Monserrat 1984a (review, some tropical American species); Monserrat 1984b (review, some African species); New 1988 (revision, Australia); New [1989] (review, New Guinea); Gonzalez Olazo 1992 (synonymy, neotropics); Oswald 1993 (phylogenetic position of genus).

Diagnosis. *Notiobiella* can be distinguished from all other extant hemerobiid genera by the following combination of forewing traits (after Oswald, 1993): (1) anterior radial trace bearing 2 prestigmal "radial sectors," (2) CuP forked proximal to crossvein 2cua-cup, and (3) prestigmal subcostal space no wider than adjacent subcostal vein [except at extreme base, adjacent to crossvein 1sc-r, where it is often somewhat wider]. Males are also characterized by an eversible, tubular, genitalic structure located between the gonarcus and parabaculum—the phallogingua—which is often strongly ornamented on its external surface when everted (Monserrat, 1984a; Monserrat and Penny, 1983). This structure probably functions as a holdfast organ during male/female coupling.

Diversity and Geographic Distribution. The 41 known, valid, extant species of the genus *Notiobiella* are collectively pantropical in distribution, being widely distributed in Central and South America (8 species), Africa (15; including Madagascar and the Seychelles), southeastern Asia (10; including Sri Lanka), Australia/New Guinea (7), and southwestern Pacific islands (1). Extant New World species range from southern Mexico south to Paraguay (6 continental spp.: *brasiliensis*, *cixiiformis*, *maculata*, *mexicana*, *paddiae*, *spinosa*), with two additional species known from the islands of Cuba (*israeli* and *pinarensis*) and Hispaniola (*israeli*). Apart from the few records of *israeli* and *pinarensis* reported by Alayo (1968) and Monserrat (1984a, 1998) from Cuba and Hispaniola, no other previously published records of *Notiobiella* species appear to exist for the islands of the West Indies. No Greater Antillean records for *Notiobiella* are contained in Smith (1931) or Wolcott (1927) for Hispaniola, Wolcott (1923, [1950]) or Leonard (1933) for Puerto Rico, or Jamaica, nor for any of the islands of the Lesser Antilles.

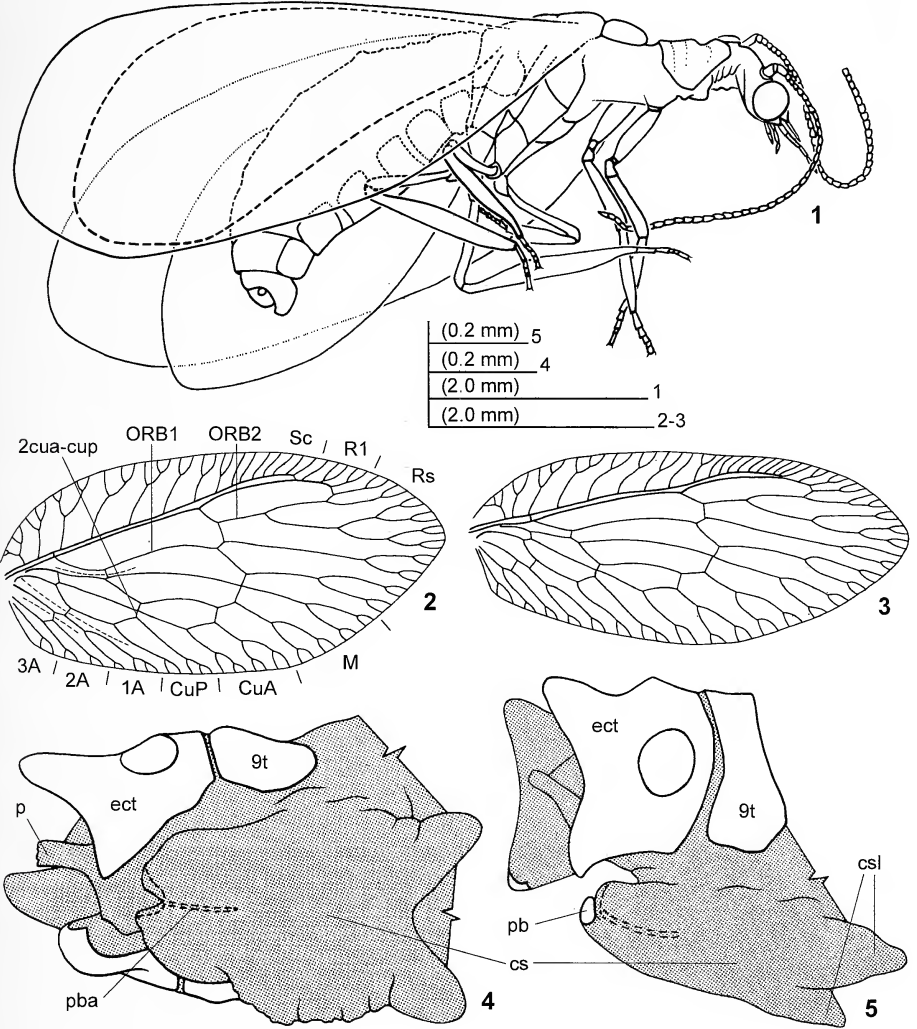
Temporal Distribution. Now documented from Recent to Miocene times. However, the broad pantropical distribution of this genus and the presence of endemic suites of species in the disjunct regions of Africa, Australia, Southeastern Asia and the New World suggest that the biogeographic distribution of this clade may have been influenced by the breakup of Gondwana. If this is true, the *Notiobiella* clade is probably of at least Cretaceous age.

Discussion. The specimens described below are the first known fossils of the genus *Notiobiella*.

***Notiobiella thaumasta*, new species**

Figs. 1–5

Description. Body coloration generally reddish-brown. *Forewing.* Length from base of tegula to wing apex 3.6–5.3 mm ($x = 4.4$; $N = 4$ wings). Venation as in Figs. 2–3. Rather short and broad, weakly angled apically. Costal space wide in basal half, narrowed distally. Veins reddish-brown, membrane hyaline, but with a darker macula surrounding crossveins 2m-cu and 2cua-cup. Anterior humeral trace recurrent and pectinately branched. Proximal subcostal veinlets branched distally. Posterior subcostal trace and anterior radial trace closely parallel. Anterior radial trace bearing



Figs. 1–5. *Notiobiella thaumasta*. 1. Female, approximately lateral view, AMNH DR-SH-18, wing venation omitted, 2. Forewing, dorsal, ♀, AMNH DR-14-1124 (right forewing), 3. Forewing, dorsal, ♂ holotype, AMNH DR-14-1124 (left forewing converted to standard right dorsal view; differences in forewing shape, especially width, between Figures 2 and 3 are distortion artifacts caused by different viewing angles and amber piece curvature), 4. Abdominal apex, ventrolateral, ♂ holotype, 5. Abdominal apex, posterolateral, ♂ holotype. Non-standard abbreviations: ect, ectoproct; ORB, oblique radial branch of radius; p, phallosingua; pb, parabaculum; pba, apophysis of parabaculum; cs, copulatory sac; cs1, copulatory sac lobes.

two widely-separated, prestigmal, oblique radial branches (ORB's = "radial sectors"), the first basal, the second near mid-wing length. Basalmost fork of proximal ORB lying near fork R1-ORB2. Fourth (distal) gradate series absent. CuP forked proximal to crossvein 2cua-cup.

Male terminalia. Tergite 9: not divided sagittally. Sternite 9: a small transverse plate. Ectoproct: bilobed posteriorly; dorsal lobe prominent, apex with a moderately dense setal aggregation; ventral lobe somewhat more slender than dorsal lobe, its apex incurved as a short spiniform process; callus cercus with trichobothria present. Gonarcus: largely hidden from view; but apex of mediuncus and phallogingua protruding from between ectoprocts. Parabaculum: terminal lobes small, apophysis short and rod-like. 9th gonocoxites: absent. Hypandrium Internum: not visible.

Female terminalia. Tergite 8: lateral ends enclosing spiracles of 8th somite. Tergite 9: not divided sagittally, expanded ventrally as in other hemerobiids. Ectoproct: subtriangular, without protruding processes; callus cercus and trichobothria present. 9th Gonocoxites: semicircular to D-shaped; stylus present. Gonapophysis Posterioris: present (visible in AMNH DR-14-1124 ♀). Subgenitale: present (visible in AMNH DR-14-1124 ♂). Insemination/fertilization Canal: not visible.

Types. Holotype ♂, AMNH DR-14-1124 (♀ paratype in same piece), condition: apices of antennae polished away, otherwise complete. Paratypes (3 ♀ ♀): (1) AMNH DR-14-1124, 1 ♀ (♂ holotype in same piece), condition: head polished away except for apices of antennae and one palp fragment, dorsa of pro- and mesothoraces polished away, otherwise complete; (2) AMNH DR-14-1129, 1 ♀, condition: tip of left forewing polished away, otherwise complete; (3) AMNH DR-SH-18, 1 ♀, condition: tip of left antenna lost, otherwise complete.

Geographic Distribution. DOMINICAN REPUBLIC: Dominican amber, no further site or stratigraphic data available (all specimens).

Temporal Distribution. The fossils reported here probably date from the mid to early Miocene (see Iturralde-Vinent & MacPhee, 1996).

Etymology. Species-group name derived from Greek *thaumastos*, wonderful or marvelous.

Discussion. No question exists about the generic affinities of this species. The specimens are well preserved and each clearly exhibits several of the following synapomorphies of this genus identified by Oswald (1993): (1) mesolateral clypeal setae present [visible on one specimen], (2) prestigmal width of forewing subcostal space narrower than width of adjacent Sc [visible on all specimens], (3) forewing CuP forked proximal to crossvein 2cua-cup (Fig. 2) [visible on all specimens], and (4) phallogingua of male genitalia present (Fig. 4, p) [visible on the single male specimen]. Additional indicative, but not synapomorphic, characters include: (5) bases of ORB1 and ORB2 widely separated along anterior radial trace (Fig. 2), (6) ORB1 stem long, i.e., first forked near divergence of ORB2 from anterior radial trace (Fig. 2), and (7) male parabaculum with small terminal lobes and a baculiform apophysis (Figs. 4–5, pb, pba).

Extant *Notiobiella* species are rigorously diagnosable on the basis of characters of the male terminalia, particularly features of the ectoprocts, gonarcus/mediuncus complex and the phallogingua. The males of seven of the eight extant New World *Notiobiella* species are known (males of *pinarensis* are unknown). *Notiobiella thaumasta* can be distinguished from these species by the following male terminalic traits

(presentation format: contrasting species name—character: state in contrasting species (figure citation) [state in *thaumasta*]): *cixiiformis* and *paddiae*—dorsal ectoproct lobe, lateral view: elongate, narrow, parallel sided (see Monserrat, 1984a:91, fig. 12 [*cixiiformis* as *rubrostigma*]; Monserrat, 1984a:95, fig. 33 [*paddiae*]) [short, broadly triangular, not parallel sided, Fig. 5]; *brasiliensis* and *maculata*—proximoventral corner of ectoproct, lateral view: narrowed, resulting in a narrow ventral ectoproct lobe (see Monserrat and Penny, 1983:128, fig. 7 [*brasiliensis*]; Penny and Monserrat, [1985]:886, fig. 11 [*maculata*]) [broad, ventral ectoproct lobe broad, Fig. 5]; *mexicana*—phallogingua, teeth of membrane: enlarged and prominent (see Monserrat, 1984a:87, figs. 4–5) [small and inconspicuous]; *spinosa*—ectoproct margin between apices of dorsal and ventral lobes, lateral view: slightly convex (see Monserrat and Penny, 1983:128, fig. 2) [distinctly concave, Fig. 5]; *israeli*—male parabaculum, terminal lobes, ventral view: divided distomedially by a rounded cleft and projecting anteriorly as a single, large, rounded lobe (Monserrat, 1984a:93, fig. 26) [divided distomedially by a V-shaped cleft and not projecting anteriorly as a large rounded lobe, Fig. 4].

Based on male terminalic traits, *thaumasta* appears to be more similar to *israeli* than to any other New World *Notiobiella* species. This close apparent relationship, together with the fact that *israeli* and *thaumasta* are both known from the island of Hispaniola, suggests that *thaumasta* may belong to the ancestral lineage of *israeli*—although this would be difficult to demonstrate conclusively.

The male and female specimens in amber piece AMNH DR-14-1124 appear to represent a formerly mated pair. This conclusion is supported by the close physical proximity of the two specimens in the piece, their opposite sexes, their entrapment in the same resin flow plane of the amber piece, and the exerted condition of the terminalia of the male. The terminalia of this male are particularly well preserved and deserve special comment. Nearly all of the external structures of the male terminalia are visible, as are some internal structures, where these are not obscured by overlying structures or the air bubble trapped within the abdomen. The most remarkable feature of this male specimen is the inflation of the membrane ventral to the 9th tergite and posterior to the 9th sternite to form a broad, flat-bottomed sac (Figs. 4–5, cs). The sac is terminated posteriorly by the terminal lobes of the parabaculum (pb)—the apophysis of which (pba) is clearly visible through the overlying membrane—and anteriorly by a pair of stout, bilaterally symmetrical, membranous lobes (csl). The entire structure is apparently an eversible sac that probably functioned as a copulatory device. Extant *Notiobiella* species should be examined for the presence of similar structures. Additional details of the male terminalia that are not normally observable in fossil hemerobiids include the narrow unornamented apex of the mediuncus and a more ventral tubular structure interpreted to be the partially exerted phallogingua.

Determination of the date of the fossils described here is complicated by: (1) the absence of precise geographical and stratigraphic information about them [e.g., mine or stratum data]; (2) the known existence of amber and “copal” deposits of widely varying ages from the Dominican Republic [Grimaldi 1995]; and (3) controversy surrounding the dating of the Dominican amber-bearing deposits [e.g., Lambert et al., 1985 vs. Iturralde-Vinent and MacPhee, 1996]. The mid to early Miocene date cited above is derived from the work of Iturralde-Vinent and MacPhee (1996), who

estimated this age for the sediments of the La Toca and Yanigua formations (which contain the main amber-producing mines northeast of Santiago) based on stratigraphic and taphonomic data. Earlier widely cited estimates of the age of ambers from this region based on nuclear magnetic resonance spectroscopy (Lambert et al., 1985; see Grimaldi, 1995 for a contrasting view) dated these ambers from the Upper Eocene.

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LITERATURE CITED

- Alayo, D. 1968. Los Neurópteros de Cuba. Poeyana Instituto de Biología (B)2:1–127.
- Anderson, K. B. and J. C. Crelling (eds.). 1995. Amber, Resinite and Fossil Resins. American Chemical Society, Symposium Series No. 617. American Chemical Society, Washington, DC. 297 pp.
- Banks, N. 1909. Hemerobiidae from Queensland, Australia. [Neuroptera, Hemerobiidae]. Proceedings of the Entomological Society of Washington 11:76–81.
- Gonzalez Olazo, E. V. 1992. Notas sobre *Notiobiella rubrostigma* Navas, 1914 (Neuroptera, Hemerobiidae). Acta Zoologica Lilloana 42:177–178.
- Grimaldi, D. A. 1995. The Age of Dominican Amber, pp. 203–217 in K. B. Anderson and J. C. Crelling (eds.), Amber, Resinite, and Fossil Resins. American Chemical Society Symposium Series, Vol. 617. American Chemical Society, Washington, DC. 297 pp.
- Grimaldi, D. A. 1996. Amber: window to the past. Harry N. Abrams Inc., New York, NY. 216 pp.
- Iturralde-Vinent, M. A. and R. D. E. MacPhee. 1996. Age and paleogeographical origin of Dominican amber. Science 273:1850–1852.
- Lambert, J. B., J. S. Frye and G. O. Poinar. 1985. Amber from the Dominican Republic: Analysis by nuclear magnetic resonance spectroscopy. Archaeometry 27:43–51.
- Leonard, M. D. 1933. An annotated bibliography of Puerto Rican entomology. Journal of the Department of Agriculture of Puerto Rico 17:5–96.
- Monserrat, V. J. 1984a. Sobre las especies Americanas del género *Notiobiella* Banks, 1909, I. (Neuroptera, Planipennia, Hemerobiidae), pp. 85–97 in J. Gepp, H. Aspöck and H. Hölzel (eds.), Progress in World's Neuropterology. Proceedings of the 1st International Symposium on Neuropterology, Graz, Austria. [Symposium held in Graz, 1980.] 265 pp.
- Monserrat, V. J. 1984b. Sobre las especies Africanas del género *Notiobiella* Banks, 1909, II. (Neuroptera, Planipennia, Hemerobiidae), pp. 99–124 in J. Gepp, H. Aspöck and H. Hölzel (eds.), Progress in World's Neuropterology. Proceedings of the 1st International Symposium on Neuropterology, Graz, Austria. [Symposium held in Graz, 1980.] 265 pp.
- Monserrat, V. J. 1990. A systematic checklist of the Hemerobiidae of the world (Insecta: Neuroptera), pp. 215–262 in Advances in Neuropterology. M. W. Mansell and H. Aspöck (eds.), Proceedings of the Third International Symposium on Neuropterology, South African Department of Agricultural Development: Pretoria. [Symposium held in Berg en Dal, Kruger National Park, 1988.] 298 pp.
- Monserrat, V. J. 1998. Nuevos datos sobre los hemeróbidos de América (Neuroptera: Hemerobiidae). Journal of Neuropterology 1:109–153.

- Monserat, V. J. and N. D. Penny. 1983. Sobre las especies Americanas del genero *Notiobiella* Banks, 1909, II (Neuroptera, Planipennia, Hemerobiidae). *Nouvelle Revue d'Entomologie* 13:125–132.
- New, T. R. 1988. A revision of the Australian Hemerobiidae (Insecta: Neuroptera). *Invertebrate Taxonomy* 2:339–411.
- New, T. R. 1988 [1989]. Hemerobiidae (Insecta: Neuroptera) from New Guinea. *Invertebrate Taxonomy* 2:605–632. *Dating: From note on reverse of contents page of v. 3, no. 1: "Volume 2, Number 5, was published on 8 May 1989".*
- Oswald, J. D. 1993. Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *Journal of the New York Entomological Society* 101: 143–299.
- Penny, N. D. and V. J. Monserat. 1983 [1985]. Neuroptera of the Amazon Basin. Part 10. Hemerobiidae. *Acta Amazonica* 13:879–909.
- Poinar, G. O. 1992. *Life in Amber*. Stanford University Press, Stanford, CA. 350 pp.
- Poinar, G. O. and L. A. Stange. 1996. A new antlion from Dominican amber (Neuroptera: Myrmeleontidae). *Experientia* 52:383–386.
- Smith, R. C. 1931. The Neuroptera of Haiti, West Indies. *Annals of the Entomological Society of America* 24:798–823.
- Wolcott, G. N. 1923. Insectae Portoricensis. *Journal of the Department of Agriculture of Puerto Rico* 7:31–35.
- Wolcott, G. N. 1927. Neuroptera, pp. 163–165 in *Entomologie d'Haiti*. Service Technique, Dept. of Agr., Port au Prince, Haiti.
- Wolcott, G. N. 1948 [1950–1951]. The insects of Puerto Rico. *Journal of Agriculture of the University of Puerto Rico* 32:1–975. *Dating: From notes on the last pages of v. 32, nos. 1 and 4. This work forms the four numbers of v. 32 published between 01.ix.1950 and 29.xi.1951.*

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NOTES ON AND DESCRIPTIONS OF NEW PAMPHANTINAE, INCLUDING FOUR NEW SPECIES OF *CATTARUS* AND A REMARKABLE NEW MYRMECOMORPHIC GENUS AND SPECIES (HETEROPTERA: LYGAEOIDEA: GEOCORIDAE)

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Abstract.—Four new species of the cattarine genus *Cattarus* Stål are described (*C. erwini* from Peru, and *C. nigritus*, *C. pseudoculatus*, and *C. pallidus* from Ecuador); *Phaeax balteatus* Distant and *P. formicarius* (Distant) are redescribed and formally transferred to *Cattarus*; *C. stysi* Slater is redescribed; the new myrmecomorphic cattarine genus *Cephalocattarus* and new species *waorani* are described from Ecuador; and new distribution records are given for the pamphantines *Parapamphantus erikae* Brailovsky from Ecuador and Venezuela, and *Tropicoparapamphantus amazonicus* Brailovsky from Ecuador and Peru. Dorsal photographs of all species (except *Cattarus insignis* Stål) and dorsal illustrations of the adults of *Cattarus formicarius*, *Cattarus stysi*, and *Cephalocattarus waorani* and its model ant species (*Cephalotes pavonii*), and a key to the eight species of *Cattarus* are given to facilitate identification.

Key words: Heteroptera, Lygaeoidea, Geocoridae, Pamphantinae, Cattarini, *Cattarus*, *Cephalocattarus*, new genus, new species, distributions.

The Pamphantinae are a peculiar New World group of ant-mimetic bugs. Until recently, they have been placed either as a subfamily of the Lygaeidae, *sensu lato* (Barber and Bruner, 1933) or as a tribe of the Bledionotinae (Scudder, 1963). Henry (1997) agreed with Scudder's (1963) interpretation that Pamphantini belonged as a tribe of Bledionotinae, which he transferred to the newly resurrected family Geocoridae, also containing Henestarinae and the nominate Geocorinae. Slater (1999), however, reviewed this classification and provided new character information supporting the recognition of Pamphantinae as a subfamily separate from Bledionotinae but still within the Geocoridae. He also expanded the tribal classification to include, in addition to the nominate Pamphantini, Cattarini, containing the genus *Cattarus*, and Epipolopini, containing the genus *Epipolops* (Slater, 1999).

In this paper, we describe four new species of *Cattarus* Stål; formally transfer to *Cattarus* and redescribe *Phaeax balteatus* Distant and *P. formicarius* Distant; redescribe *C. stysi* Slater; provide a key to the eight species of *Cattarus*; describe the new cattarine genus *Cephalocattarus* and new species *waorani* from Ecuador; and give new distribution records for the pamphantines *Parapamphantus erikae* Brailovsky and *Tropicoparapamphantus amazonicus* Brailovsky. Dorsal photographs of all species, except *Cattarus insignis* Stål, and dorsal habitus illustrations of *Cattarus formicarius*, *Cattarus stysi*, and of *Cephalocattarus waorani* and its model ant species *Cephalotes pavonii* (Latrielle) are furnished to aid in identification.

All taxa in this paper are arranged alphabetically by genus and species. Measurements are given in mm. Acronyms for depositories of specimens are as follows: BNHM (The [British] Natural History Museum, London), JAS (J. A. Slater collection, Storrs, CT), MNRJ (Museu Nacional, Rio de Janeiro), NMNH (National Museum of Natural History, Smithsonian Institution, Washington, DC), and TAMU (Texas A & M University, College Station).

Cattarus Stål

Cattarus Stål 1860: 41; Slater 1999: 203. Type species: *Cattarus insignis* Stål. Monobasic.

Phaeax Distant 1893: 413; Hussey 1929: 26; Woodward 1962: 122; Scudder 1963: 82; Slater 1964: 1162; Slater and O'Donnell 1995: 73. Type species: *Phaeax formicarius* Distant. Designated by Hussey 1929. Synonymized by Slater 1999: 203.

Description. Head broader than long, ocelli small, widely spaced near inner margin of eyes; buccula evenly narrow, extending posteriorly to stridulitrum (stridulitrum also continuing onto anterior margin of prosternum), labium extending beyond mesocoxae to middle of mesosternum. Antenna slender, segment I shortest, barrel shaped; segments II and III terete, II longest, both weakly clavate, IV slenderly fusiform. Pronotum bilobed, rounded laterally, without spines, strongly constricted at middle; anterior lobe impunctate, broadest anteriorly, contiguous with hind margin of eyes and base of head, narrowing posteriorly; posterior lobe sparsely punctate, width across humeral angles subequal to anterior width of front lobe; scutellum nearly equilateral, deeply punctate. Hemelytra entire, strongly constricted at middle; clavus with two parallel rows of punctures, corium with one row of punctures bordering claval commissure and extending along margin of membrane; usually with a white fascia near constriction about level of apex of clavus and a narrow white band across apex of corium and base of membrane. Abdomen bulbous, strongly constricted at base; segments II and III fused, segment III with a pubescent ridge or tubercle at middle; spiracles II–IV dorsal; V–VII ventral. Fore femur incrassate with a stout subapical spine; middle and hind femora moderately swollen; tibiae slender. Body generally with scattered long, erect, simple setae, often interspersed with patches or bands of silvery sericeous setae, particularly laterally on pronotum and abdomen.

Discussion. With the description of four new species in this paper, eight species of *Cattarus* are now known (Slater, 1964, 1999).

KEY TO THE SPECIES OF *CATTARUS*

- 1 Head and pronotum yellow, usually with a large black spot at antero-lateral pronotal angles 2
- 1' Head and pronotum black or chiefly black, at most with orange stripes 3
- 2 Corium with a dark brown triangular mark laterally at level of apex of claval commissure immediately behind white quadrate macula; corium with a conspicuous black spot at apex; compound eye relatively short, interocular space at least one and three fourths length of eye *C. pseudoculatus*, n.sp.
- 2' Corium lacking a dark mark at posterior margin of white macula and without a black spot at apex of corium; eyes relatively more elongate, interocular space not or only slightly greater than one and one half times length of eye *C. pallidus*, n.sp.

- 3 Posterior pronotal lobe with a smooth impunctate area posteriorly between humeral angles *C. nigritus*, n.sp.
- 3' Posterior pronotal lobe completely and conspicuously punctate including area across humeral angles 4
- 4 Membrane of forewing white with a large black median spot *C. insignis* Stål
- 4' Membrane of forewing black, at most with a narrow pale stripe across membrane immediately behind apex of corium, otherwise with only small white spots 5
- 5 Clavus variegated, inner half dark brown, outer half yellow; second antennal segment much longer than interocular space *C. styasi* Slater
- 5' Clavus completely dark chocolate brown to black; second antennal segment shorter than, or at most subequal to interocular space 6
- 6 Corium with a large quadrate orange macula bordered anteriorly by a dark stripe at level of apex of claval commissure; femora yellowish *C. erwini*, n.sp.
- 6' Corium dark, lacking an orange quadrate macula at level of apex of claval commissure; femora black 7
- 7 Membrane with a complete narrow white band running across entire membrane immediately behind apices of coria *C. balteatus* (Distant)
- 7' Membrane with only a small white triangular area adjacent to apex of corium and small spots between apical corial margins *C. formicarius* (Distant)

Cattarus balteatus (Distant), **new combination**

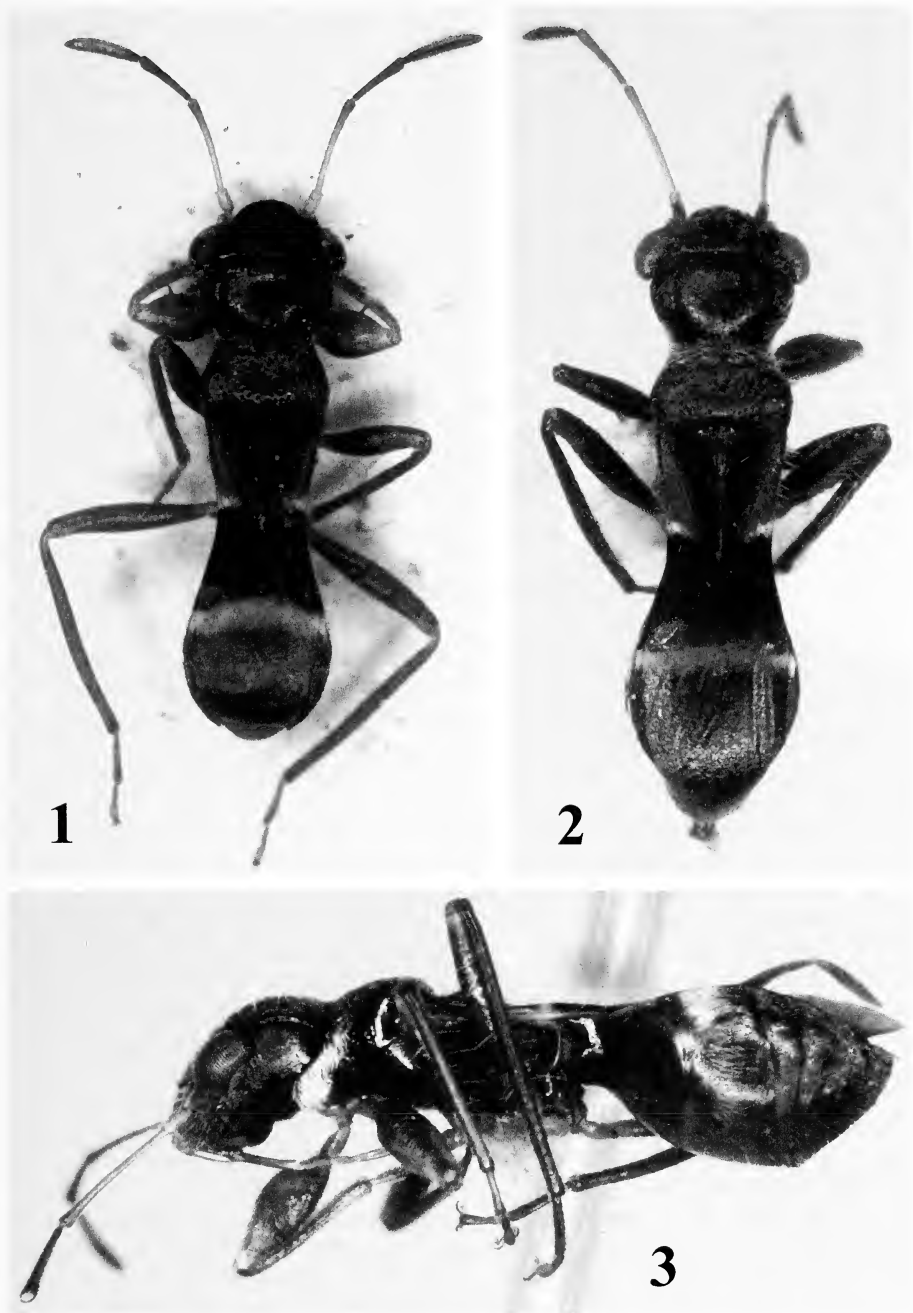
Figs. 1-3

Phaeax balteatus Distant 1893: 413; Woodward 1962: 122; Slater 1964: 1162.

Description. Relatively small, dark species, almost entirely black. A narrow, mesally tapering white triangular area on corium slightly anterior to level of end of claval commissure and a complete, straight, narrow white stripe across membrane immediately posterior to apex of corium (this extended onto adjacent area of abdominal sternum as a cluster of silvery hairs). Antenna, fore tibia, distal ends of middle and hind tibiae, tarsi and labium sordid brown, fourth antennal segment darker.

Anterior pronotal lobe very broad at anterior end, as broad as area across pronotal humeral angles. Abdomen swollen, elliptical. Posterior pronotal lobe densely punctate over entire surface. Body and legs with very long hairs. Pronotum laterally with a conspicuous fringe of silvery hairs adjacent to base of head. Head length 0.76, head width 1.22, interocular space 0.76. Anterior pronotal lobe length 0.62. Posterior pronotal lobe length 0.60, pronotal width 0.94. Scutellar length 0.36, scutellar width 0.42. Claval commissure length 0.50. Midline distance from apex of clavus to apex of corium 0.60. Midline distance from apex of corium to apex of abdomen 1.40. Antennal segment lengths I 0.20, II 0.78, III 0.48, IV 0.68. Labial segment lengths I 0.34, II 0.36, III 0.24, IV 0.42. Total body length 4.56.

Variation: Male and female paratypes in order. Head length 0.70-0.72, head width 1.20-1.24, interocular space 0.74-0.76. Anterior pronotal lobe length 0.62-0.66, posterior pronotal lobe length 0.56-0.60, pronotal width 0.94-1.20. Scutellar length 0.32-0.38, scutellar width 0.36-0.42. Claval commissure length 0.54-0.54. Midline distance from apex of clavus to apex of corium 0.62-0.68. Midline distance from apex of corium to apex of abdomen 1.20-1.31. Antennal segment lengths I 0.18-0.20, II 0.76-0.88, III 0.50-0.56, IV 0.68-0.66. Labial segment lengths I 0.32-0.40, II 0.32-0.40, III 0.28-0.32, IV 0.46-0.42.



Figs. 1–3. Photographs of *Cattarus balteatus* (Distant). 1, lectotype ♂, dorsal aspect. 2, adult ♀, dorsal aspect. 3, adult ♀, lateral aspect.

Discussion. This species was described and previously only known from Panama. Brazil is a new country record.

Material examined. BRAZIL: 1 ♂, Amazonas Hwy ZF 2, km 20.7, ca. 60 km N. Manaus, 02°30'S, 60°15'W, 16.viii.1979, Terre Firme Canopy fogging project TRS # 08, Tray 536, Adis, Erwin, Montgomery et al. collectors (NMNH); 1 ♂, 1 ♀, Amazonas, Hwy ZF 2, km 19.5, ca. 60 km N. Manaus, 02°30'S, 60°15'W, 18.viii.1979, Terre Firme Canopy fogging project TRS # 10, "Col. by hand," Adis, Erwin, Montgomery et al. collectors (JAS, NMRJ). PANAMA: Lectotype ♂, label 1 (circular, with red ring), "Type"; 2 (handwritten), "Phaeax balteatus Dist"; 3, "Bugaba, 800–1500 ft. Champion"; 4, "Sp. figured."; 5 (circular, with purple label), "Lectotype"; 6 (handwritten), "LECTOTYPE *Phaeax balteatus* Distant sel. T. E. Woodward 1961." (BNHM).

Cattarus erwini, new species

Figs. 4, 5

Description. Head, pronotum and scutellum black, except head anterior to eyes dull yellow. Clavus dark chocolate brown (almost black) with a very narrow yellow inner margin along claval commissure. Hemelytra variegated as follows: basal and distal one-third of corium black; a quadrate white macula at level of distal third of claval commissure bordered posteriorly by a narrow black fascia, posterior to which is a large quadrate orange macula. Membrane dark between coria except for a round white spot near inner anterior end of membrane. Membrane mostly black, pale laterally, with a lunate, white, transverse fascia at base. Legs and antenna sordid yellow, but antenna with distal end of segment two, proximal end of segment three, and lateral and median stripes on segment four black. Posterior half of each abdominal connexivum with a large black macula. Dorsal surface with only a few scattered setae. Transverse pronotal impression with band of decumbent, sericeous silvery setae that continues laterally and ventrally to reach forecoxae. Anterior margin of mesopleuron with a narrow conspicuous band of silvery setae.

Head length 0.76, width 1.30, interocular space 0.84. Anterior pronotal lobe length 0.80, width 1.02, posterior pronotal lobe length 0.80, width 1.02. Scutellar length 0.44, width 0.44. Claval commissure length 0.58. Midline distance from apex of clavus to apex of corium 0.76. Midline distance from apex of corium to apex of abdomen 1.60. Labial segment lengths I 0.34, II 0.34, III 0.24, IV 0.34. Antennal segment lengths I 0.18, II 0.80, III 0.42, IV 0.60. Total body length 5.22.

Etymology. This species is named after Terry L. Erwin, whose well-known canopy fogging studies in Brazil, Ecuador, Panama, and Peru have completely revised our thinking about the numbers of species on this planet, and have yielded many new and rare Heteroptera, including this new species from Peru.

Discussion. This species resembles *C. nigrinus* in many ways, but is noticeably less elongate and is more robust. It is also readily separable by the lack of a smooth area posteriorly on the posterior pronotal lobe, the much narrower silvery band of sericeous setae in the area of the transverse pronotal impression, the pale legs, and the large quadrate orange patch that completely crosses the corium. In *C. nigrinus* the middle and hind femora are black and contrast strongly with the sordid yellow fore femur. In *C. erwini* all of the legs are sordid yellow, although the middle and hind



Figs. 4–6. Photographs of *Cattarus* spp. 4, 5, *Cattarus erwini*, n. sp. 4, adult ♀, dorsal aspect. 5, adult ♀, lateral aspect. 6, *Cattarus formicarius* (Distant), lectotype ♂, dorsal aspect.

femora of the paratype female are somewhat infuscated. *Cattarus erwini* also has a more conspicuous line of punctures near the anterior margin of the pronotum.

The measurements of the female paratype are as follows: head length 0.82, head width 1.46, interocular space 0.94. Anterior pronotal lobe length 0.72, posterior pronotal lobe length 0.70, pronotal width 1.24. Scutellar length 0.42, scutellar width 0.48. Claval commissure length 0.58. Midline distance from apex of clavus to apex of corium 0.84. Midline distance from apex of corium to apex of abdomen 1.94. Antennal segment lengths I 0.22, II 0.84, III 0.46, IV 0.64. Labial segment lengths I 0.46, II 0.42, III 0.31, IV 0.42.

Types. Holotype, ♂: PERU, Madre de Dios, Rio Tambopata Res., 30 km (air) SW Pto. Maldonado, 290 m, 12°50'S, 69°17'W (Smithsonian Institution Canopy fogging Project), T. L. Erwin et al. colls., 30.iv.1984, "03/03" (held in trust at NMNH). Paratype: 1 ♀, same data as for holotype except 10.xi.1983 "03/02" (NMNH).

Additional material examined. A third specimen (a female which is very teneral) taken from this locality on 9. iii. 1984 almost certainly represents a different species. This specimen has a very coarsely punctate pronotum, black femora on all legs, red middle and hind tibiae, and dark antennae, and lacks the quadrate orange macula on the corium.

Cattarus formicarius (Distant), **new combination**

Fig. 6, 7

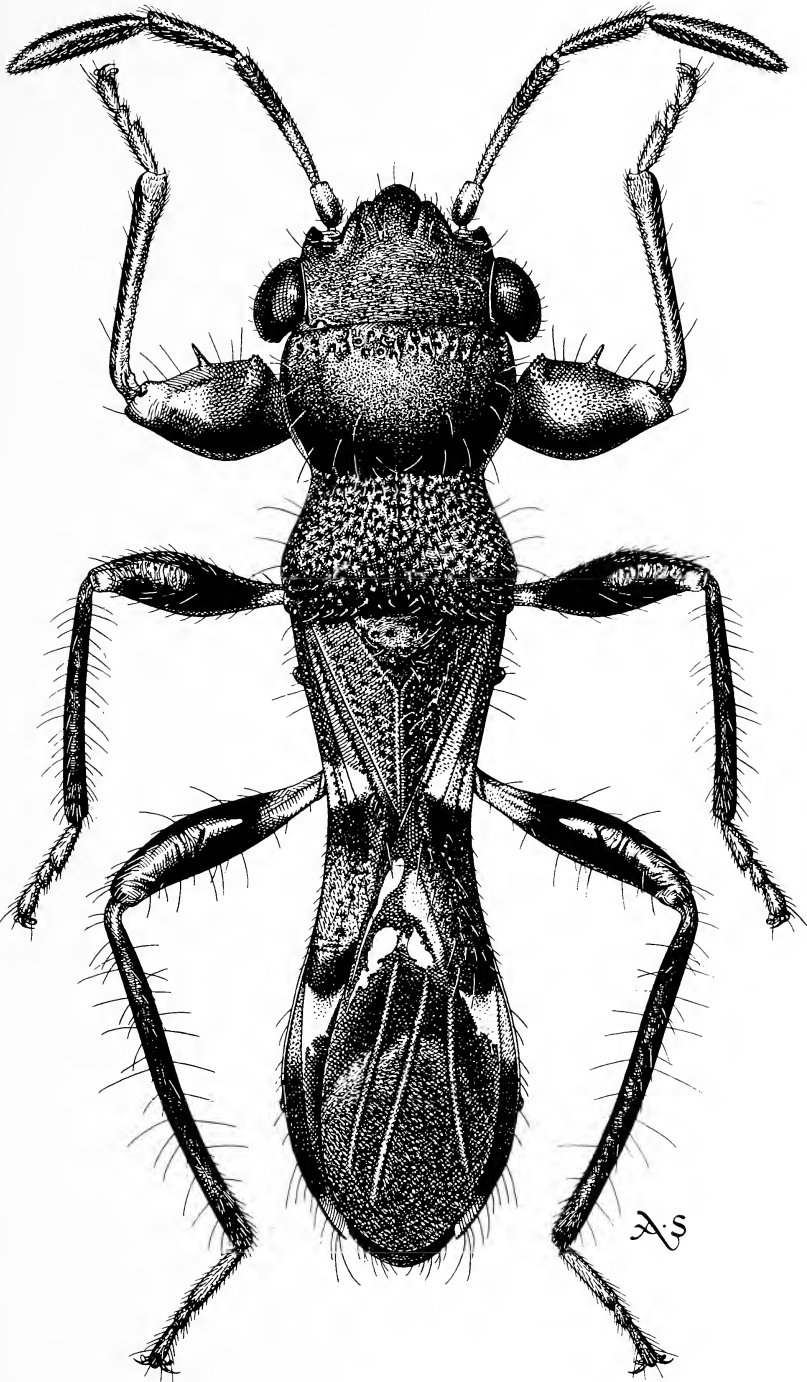
Phaeax formicarius Distant 1893: 413; Woodward. 1962: 122; Slater 1964: 1162.

Description. Overall coloration black, including femora, tibiae, basal half of antennal segment one, distal half of segment two and all of segments three and four. Tarsi sordid yellow. Hemelytra marked with white as follows: a transverse quadrate macula on corium at level of distal third of claval commissure extending from lateral corial margin to claval suture; three irregular spots on membrane between apical corial margins, anterior one near base of membrane and a pair at level of distal one-third of apical corial margin; a large triangular macula immediately beyond apex of corium, tapering caudo-laterad. Dorsal surface dull, finely granulose. Two rows of large coarse punctures immediately behind anterior margin of pronotum and extending onto propleuron, remainder of anterior pronotal lobe impunctate. Posterior pronotal lobe completely covered with coarse punctures. Body and appendages bearing elongate, upstanding hairs. Fore femur strongly incrassate, with a single large ventral spine and with plectron strongly produced.

Head moderately declivent, head length 0.78, width 1.31, interocular space 0.90. Anterior pronotal lobe length 0.96; posterior pronotal lobe length 0.62. Width across pronotal humeral angles 1.16. Scutellar length 0.40, width 0.44. Claval commissure length 0.60. Midline distance from apex of clavus to apex of corium 0.86. Midline distance from apex of corium to apex of abdomen 1.60. Length of antennal segments I 0.22, II 0.72, III 0.46, IV 0.70. Total body length 5.32.

Discussion. This species was described and is still only known from Panama.

→



Material examined. Lectotype, ♂: label 1 (circular, with purple ring), "Lectotype"; 2, "V. De Chiriqui, 25-4000 ft. Champion."; 3 (handwritten), "Phaeax formicarius Dist."; 4, "B. C. A. Hem. I Phaeax formicarius"; 5 (pale blue), "Figured A. Smith"; 6 (handwritten), "LECTOTYPE *Phaeax formicarius* Distant sel. T. E. Woodward 1961." (BNHM).

Cattarus insignis Stål

Cattarus insignis Stål 1860: 42; Scudder 1963: 88; Slater 1964: 617.

Discussion. This, the type species of *Cattarus*, has been adequately redescribed and illustrated by Scudder (1963). It is a relatively short and robust species. One of us (JAS) examined a male from "S. Paulo 7.XI.1926," which has the dorsal surface black except as follows: a strongly contrasting quadrate white macula across corium at level of distal end of claval commissure, a white oblong vitta at base of membrane followed by a pale gray area between coria, followed by a lunate white band across membrane immediately posterior to apices of coria; remainder of membrane black. Femora dark brown, paler at distal ends. Middle and hind tibiae reddish. This specimen has only the first two antennal segments, both pale yellow with the distal end of segment two infuscated. This specimen is certainly conspecific with *C. insignis*. Its measurements are as follows: Head length 0.76, head width 1.28, interocular space 0.76. Anterior pronotal lobe length 0.70, posterior pronotal lobe length 0.60, pronotal width 1.04. Scutellar length 0.36, scutellar width 0.44. Claval commissure length 0.56. Midline distance from apex of clavus to apex of corium 0.80. Midline distance from apex of corium to apex of abdomen 1.62. Antennal segment lengths I 0.20, II 0.70; III and IV absent. Labial segment lengths I 0.36, II 0.31, III 0.28, IV 0.36.

A second male from "Sao Paulo Serra de Bocaina, S. Jose Barrero, I.1969, 1650 m (M. Alvarenga)" that appears to be conspecific is quite differently colored in that the following areas are bright orange: head anterior to eyes, anterior and lateral margins of anterior pronotal lobe, greater part of posterior pronotal lobe, entire clavus, a large triangular macula on each corium posterior to distal end of claval commissure (this separated from the white corial macula only by a narrow transverse black band across corium); almost entire pleural and ventral surface of thorax orange.

Scudder's (1963) redescription of the type specimens mentions ferrugineous areas anteriorly on the head and "sometimes" the anterior margin and the hind lobe of the pronotum dark brown rather than black, and a "subapical" ferrugineous elongate triangular spot on the corium.

Cattarus nigrinus, new species

Figs. 8, 9

Description. Head, pronotum, scutellum, and entire clavus black. Corium with a broad white transverse fascia at level of distal one-third of claval commissure. Remainder of corium black except for a small orange spot at inner angle adjacent to apex of claval commissure. Membrane narrowly dark at base, followed by a pale area and then a dark band, this followed by a lunate white band immediately caudad of corial apex, membrane entirely black posteriorly. Head anterior to base of anten-



8



9

Figs. 8, 9. Photographs of *Cattarus nigrinus*, n. sp. 8, adult ♂, dorsal aspect. 9, adult ♂, lateral aspect.

niferous tubercles, first and proximal one-third of second antennal segments, fore and middle tibiae, and all tarsi dull yellow. Fore femur pale, but somewhat infuscated with sordid brown, strongly contrasting with black middle and hind femora, and distal two-thirds and all of third and fourth antennal segments. Fore and middle acetabula laterally, and posterior lobe of metapleuron white. Dorsal surface and legs bearing numerous elongate erect hairs. Head and pronotal transverse impression clothed with numerous decumbent silvery sericeous hairs. Anterior margin of anterior pronotal lobe lacking a deep series of coarse punctures, only a few scattered punctures present, nearly impunctate. Posterior pronotal lobe and scutellum coarsely

punctate. Clavus and outer half of dark area of corium beyond transverse white fascia pruinose, contrasting with shining remainder of dorsal body surface.

Body elongate, slender. Head sloping downward to apex. Head length 0.66, width 1.32, interocular space 0.84. Swollen anterior pronotal lobe very slightly broader than width across humeral angles. Transverse impression deep. Anterior pronotal lobe length 0.68, width 1.10; posterior pronotal lobe length 0.62, width 1.08. Scutellum mesally elevated. Scutellar length 0.40, width 0.44. Claval commissure length 0.70. Corial margins moderately narrowed. Midline distance from apex of clavus to apex of corium 0.92. Midline distance from apex of corium to apex of abdomen 1.76. Metathoracic scent gland auricle straight, evaporative area large, occupying entire anterior lobe of metapleuron, similar to *C. styxi*. Fore femur incrassate with a single conspicuous ventral spine on distal half and prominent elevated spinules forming a plectron ventrally near base. Stridulitrum on head conspicuous, lunate. Labium extending onto mesosternum. Labial segment lengths I 0.32, II 0.30, III 0.30, IV 0.36. Antenna relatively slender, third segment scarcely enlarged, not conspicuously fusiform. Antennal segment lengths I 0.20, II 0.76, III 0.40, IV 0.70. Total body length 5.98.

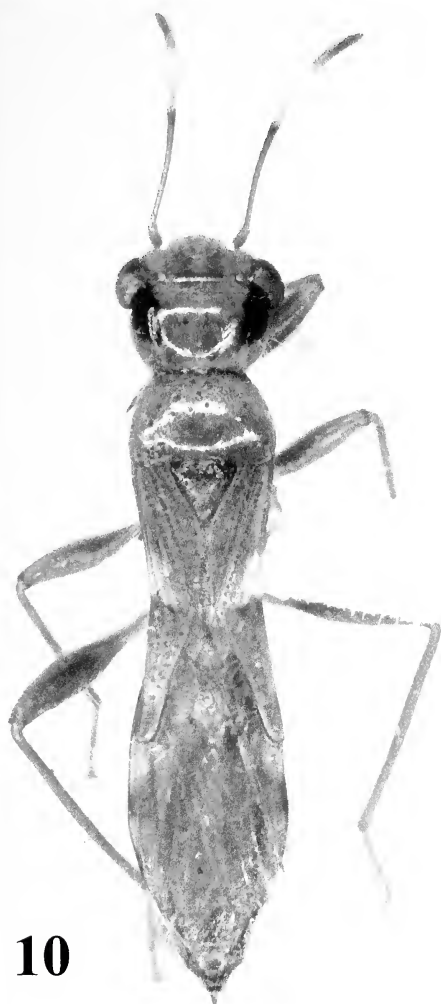
Variation in measurements Males (N = 5; N = 4 on antennal and labial measurements), females (N = 3; means and range given first for males followed by same data for females). Head length 0.80 (0.76–0.82)–0.90 (0.82–0.94), head width 1.34 (1.32–1.40)–1.42 (1.40–1.42), interocular space 0.86 (0.84–0.92)–0.92 (0.90–0.94). Anterior pronotal lobe length 0.76 (0.72–0.80)–0.82 (0.76–0.84), posterior pronotal lobe length 0.70 (0.68–0.72)–0.72 (0.70–0.76), pronotal width 1.12 (1.04–1.18)–1.20 (1.12–1.22). Scutellar length 0.40 (0.36–0.46)–0.44, scutellar width 0.44 (0.42–0.46)–0.50 (0.46–0.56). Claval commissure length 0.64 (0.62–0.66)–0.70 (0.64–0.76). Midline distance from apex of clavus to apex of corium 0.90 (0.88–0.94)–1.00 (0.92–1.02). Midline distance from apex of corium to apex of abdomen 1.88 (1.84–1.96)–1.94 (1.84–1.96). Antennal segment lengths I 0.20 (0.18–0.22)–0.22, II 0.76 (0.70–0.80)–0.84 (0.82–0.86), III 0.36 (0.34–0.38)–0.34 (0.32–0.36), IV 0.72 (0.66–0.82)–0.70 (0.68–0.70). Labial segment lengths I 0.40 (0.38–0.42)–0.42, II 0.38 (0.36–0.40)–0.40 (0.38–0.42), III 0.30 (0.32–0.40)–0.34 (0.32–0.36), IV 0.38 (0.32–0.40)–0.42.

Etymology. This species is named for its black coloration.

Discussion. The general body form is most similar to *C. styxi*.

Types. Holotype, ♂: ECUADOR, **Napo** [Prov.], Reserve Ethnica Waorani, 1 km S. Onkone Gare camp, Trans. Ent., 12.ii.1995, 220 m, 00°39'10"S, 76°26'00"W, T. L. Erwin et al., insecticidal fogging from mostly green leaves some with covering of lichenous or bryophytic plants in terre firme forest, at Trans. 6, Sta. 4, Project MAXUS, Lot 1033 (held in trust at NMNH). Paratypes (all data same as for holotype except for date, Trans. No., and/or Lot No.): ECUADOR, **Napo**: 1 ♀, same except Lot 936; 1 ♂, same except Lot 922; 1 ♂, same except Lot 885; 1 ♂, same except Lot 929; 1 ♂, same except 12.ii.1995, at Trans. 6, Lot 1033; 1 ♀, same except Lot 1032; 1 ♀, same except "220 m, 9.x.1994, 00°39'10"S, 76°26'00"W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves some with covering of lichenous or bryophytic plants in terre firme forest at Trans. 5, Sta. 7, Project MAXUS, Lot 916 (JAS and NMNH).

Additional material examined. 3 ♂♂, 1 ♀, same data as for holotype, except



10



11

Figs. 10, 11. Photographs of *Cattarus pallidus*, n. sp. 10, adult ♀, dorsal aspect. 11, adult ♀, lateral aspect.

18.i.1994 and x-trans 1. These specimens are probably conspecific with *C. nigratus*, but are somewhat larger, with the membrane of the front wing almost entirely black beyond the white lunate band.

***Cattarus pallidus*, new species**

Figs. 10, 11

Description. General coloration bright yellow with a large black macula present on either side of pronotum, simulating eye spots laterally on anterior half of anterior

pronotal lobe. Corium with a large white trianguloid white area at level of posterior two-thirds of claval commissure, lacking a dark marking along transverse posterior edge of white marking. Apex of corium uniformly pale yellow, without a dark apical spot. Coxae, metathoracic scent gland auricle and posterior lobe of metapleuron white. Compound eye relatively elongate. Head length 0.92, head width 1.52, interocular space 0.90. Anterior pronotal lobe length 0.80, posterior pronotal lobe length 0.70, pronotal width 1.32. Scutellar length 0.58, scutellar width 0.58. Claval commissure length 0.72. Midline distance from apex of clavus to apex of corium 1.16. Midline distance from apex of corium to apex of abdomen 2.00. Antennal segment lengths I 0.24, II 1.10, III 0.52, IV 0.74. Labial segment lengths I 0.50, II 0.48, III 0.38, IV 0.46. Total body length. 6.81.

Variation: Males (N = 3), followed by female (N = 1). Head length 0.90 (0.90–0.92)–1.08, head width 1.50 (1.48–1.52)–1.62, interocular space 0.90 (0.88–0.90)–1.00. Anterior pronotal lobe length 0.78 (0.76–0.80)–0.86, posterior pronotal lobe length 0.76 (0.70–0.80)–0.86, pronotal width 1.30 (1.28–1.31)–1.42. Scutellar length 0.56 (0.56–0.58)–0.62, scutellar width 0.56 (0.54–0.58)–0.58. Claval commissure length 0.68 (0.66–0.72)–0.84. Midline distance from apex clavus to apex corium 1.16 (1.14–1.18)–1.31. Midline distance from apex corium to apex abdomen 1.90 (1.84–2.00)–2.40. Antennal segment lengths I 0.24–0.24, II 1.08 (1.06–1.10)–1.16, III 0.50 (0.50–0.52)–0.60, IV 0.76 (0.74–0.76)–0.76. Labial segment lengths I 0.50 (0.50–0.52)–0.46, II 0.49–0.50, III 0.38 (0.38–0.40)–0.42, IV 0.46–0.50.

Discussion. We have examined a single male (NMNH) from Peru that may be conspecific, but it has a noticeable dark transverse line across the corium immediately posterior to the white marking. It is very similar in shape and general coloration to *C. pseudoculatus*.

Etymology. This species is named for its overall yellow or pallid coloration.

Types. Holotype, ♂: ECUADOR, **Napo** [Prov.], Res. Ethnica Waorani, 1 km S. Onkone Gare Camp, Trans. Ent, 11.ii.1995, 220 m, 00°39'10"S, 76°26'00"W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves some with covering of lichenous or bryophytic plants in terre firme forest at Trans 4, Sta 2, Project MAXUS, Lot 1021 (held in trust at NMNH). Paratypes: ECUADOR, **Napo**: 1 ♀, same data as for holotype except 25.i.1994, 00°38'S, 76°36'W, x-trans 5, 45 m, Lot 654; 1 ♂ same as for holotype except 9.x.1994, 00°39'S, 76°35'W at Trans. 5, Sta. 5, Lot 914; 1 ♂, same data as for holotype except 7.x.1994, at Trans 8, Sta. 3, Lot 902; 1 ♀, same as for holotype except 8.ii.1995, at Trans 10, Sta. 5, Lot 964 (JAS and NMNH).

***Cattarus pseudoculatus*, new species**

Figs. 12, 13

Description. Color chiefly pale yellow. A large strongly contrasting black macula present in antero-lateral corners of pronotum that tapers posteriorly and curves mesally to reach middle of anterior pronotal lobe. Head, pronotum, scutellum, and clavus otherwise uniformly pale yellow. Corium with a complete transverse quadrate white fascia at level of distal third of claval commissure, bordered posteriorly along lateral half by an ovoid or triangular black macula. Apex of corium also with a conspicuous black spot. A series of black patches laterally on posterior half of abdominal con-



Figs. 12, 13. Photographs of *Cattarus pseudocolatus*, n. sp. 12, adult ♂, dorsal aspect. 13, adult ♂, lateral aspect.

nexiva 4–7. Distal end of antennal segment two slightly infuscated, proximal end of segment three with a black annulus, segment four with an elongate dark stripe on outer and inner surfaces.

Head broad, sloping downward to anterior end, tylus nearly attaining distal end of first antennal segment. Eyes large, elliptical, sessile, extending well laterad of pronotum. Head length 0.80, width 1.32, interocular space 0.88. Ocelli placed very close to compound eyes. Pronotum with transverse impression very deep. Anterior pronotal lobe swollen, as wide as posterior lobe across humeral angles, with a few scattered minute punctures. Posterior pronotal lobe sloped downward from transverse impression to scutellum and coarsely punctate. Anterior pronotal lobe length 0.72, width 1.08, posterior pronotal lobe length 0.64, width 1.10. Scutellum swollen and elevated mesally, coarsely punctate. Scutellar length 0.40, width 0.48. Hemelytra

constricted, narrowest at level of posterior end of claval commissure. Claval commissure length 0.62. Midline distance from apex of clavus to apex of corium 0.82. Midline distance from apex of corium to apex of abdomen 1.78. A broad stridulitrum occupying most of lateral surface of head. Plectron present ventrally on proximal third of fore femur, consisting of an elevated area of short tubercles. A single large ventral spine present distally on fore femur. All femora moderately incrassate, bearing a series of elongate upstanding setae. Labium short, barely attaining anterior portion of mesosternum and thus only slightly extending posteriorly beyond anterior coxae. Labial segment lengths I 0.38, II 0.36, III 0.24, IV 0.38. First three antennal segments terete, segment four fusiform. Antennal segment lengths I 0.22, II 0.78, III 0.40, IV 0.66. Total body length 6.57.

Variation: Mean and variation of males followed by same for females (Males N = 6; females N = 2). Head length 0.79 (0.76–0.84)–0.81 (0.80–0.82), head width 1.30 (1.28–1.34)–1.40, interocular space 0.81 (0.80–0.84)–0.96. Anterior pronotal lobe length 0.72 (0.64–0.76)–0.79 (0.76–0.82), posterior pronotal lobe length 0.66 (0.62–0.76)–0.71 (0.68–0.74), pronotal width 1.10 (1.08–1.14)–1.21 (1.20–1.22). Scutellar length 0.42 (0.40–0.44)–0.45 (0.44–0.46), scutellar width 0.44 (0.40–0.48)–0.49 (0.48–0.50). Claval commissure length 0.64 (0.62–0.64)–0.69 (0.68–0.70). Midline distance from apex of clavus to apex of corium 0.86 (0.80–0.90)–0.96 (0.94–0.98). Midline distance from apex of corium to apex of abdomen 1.66 (1.56–1.78)–1.75 (1.70–1.80). Antennal segment lengths I 0.21 (0.20–0.22)–0.22, II 0.78 (0.76–0.80)–0.86 (0.84–0.88), III 0.41 (0.40–0.44)–0.42 (0.40–0.44), IV 0.66 (0.64–0.68)–0.68. Labial segment lengths I 0.36 (0.36–0.38)–0.40, II 0.34 (0.34–0.36)–0.38 (0.36–0.40), III 0.28 (0.24–0.30)–0.30 (0.28–0.31), IV 0.35 (0.32–0.38)–0.39 (0.36–0.42).

Etymology. This species is named for the appearance of large eye-like spots created by the black patches on the antero-lateral pronotal angles of most of the specimens.

Types. Holotype, ♂: ECUADOR, **Napo** [Prov.], Res. Ethnica Waorani, 1 km S. Onkone Gare camp, Trans. Ent., 20.i.1994, 220 m, 00°38'S, 76°26'W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves, some with covering of lichens or bryophytic plants, Project MAXUS, at x-trans 7, 58 m., Lot 614 (held in trust at NMNH). Paratypes (all of the following specimens from the same locality as for holotype with exceptions of dates and transect numbers as noted): ECUADOR, **Napo**: 1 ♂ same; 1 ♀, except 15.i.1994, x-trans 6, 81 m, Lot 578; 1 ♀, same except 12.ii.1995, at Trans. 5, Sta. 5, Lot 1044; 1 ♂, same except 8.ii.1995 at Trans. 10, Sta. 3, Lot 962; 1 ♂, 00°39'10'S, 76°26'00'W, 25.vi.1994 at 5 x-trans., 70 m., Lot 736; 1 ♂, same except 21.vi.1994, at 7 x-trans, 58 m, Lot 695; 1 ♂, 12.ii.1995, at Trans 6, Sta 9, Lot 1038; 1 ♂, same except 8.ii.1995 at trans 10, Sta 8, Lot 962; 1 ♂, same except 5.x.1994, at trans 10, Sta 8, Lot 887; 1 ♂, same except 9.ii.1995 at Trans 2, Sta 9, Lot 988; 1 ♀, same except 7.x.1994, at Trans 8, Sta 2, Lot 901, Smithsonian Institution canopy fogging project, T. L. Erwin et al. (BNHM, JAS, and NMNH).

Additional material examined. ECUADOR, **Napo**: 1 ♂, 2 ♀♀, same data as for holotype, except with dates 4.x.1994 (Lot 868), 10.x.1994 (Lot 935), and 9.ii.1995 (Lot 988). These three specimens lack the characteristic black pronotal patches, but otherwise seem to be conspecific.

Cattarus stysi Slater

Figs. 14–16

Cattarus stysi Slater 1999: 204.

Redescription. Since the journal in which this species was described may not be available to many readers, we include the original description here.

“Coloration chiefly black, shading to dark brown. Head mesally, anterior pronotal lobe and scutellum black. Juga and broad lateral area of head dull yellow. A narrow yellow stripe across anterior pronotal margin. Posterior pronotal lobe mesally broadly pale yellow, lateral two-thirds fuscous. Inner half of clavus and corium caudad of apex of clavus rich red-brown, outer one-half of clavus contrastingly yellow. A broad white transverse fascia across corium at level of distal one-half of claval commissure. Corium anterior to this fascia dark brown laterally, pale yellow mesally with a line of contrastingly dark punctures adjacent to claval suture. Membrane complexly variegated as follows: extreme basal area black, becoming yellow at level of middle of apical corial margins, a broad white crescent shaped transverse band across membrane beginning laterally just caudad of apex of corium, curving anteriorly between coria mesally, area immediately caudad of white band fumose with veins dull yellow. Fore and mid acetabula laterally and posterior metapleural lobe white. Hind acetabulum yellow-brown, concolorous with trochanters and most of femora and fore and middle tibiae; hind tibiae contrastingly reddish brown for most of length, becoming pale yellow-tan on distal ends. Antennal segment one pale yellowish-brown. Abdominal venter red-brown with strongly contrasting orange-yellow connexiva on segments 5–7 and anterior one-half of connexivum 4. Body and legs clothed with numerous elongate upright hairs, also with numerous declivent silvery hairs on transverse pronotal impression, head laterally and scutellum. Head and swollen calli area of anterior pronotal lobe nearly impunctate. Pronotum with a series of deep anastomosing punctures immediately behind smooth anterior margin. Posterior pronotal lobe and scutellum conspicuously punctate. Clavus with three rows of punctures. Body surface shining, except for pruinose clavus and a broad pruinose fascia on anterior one-half of dark corial color immediately behind white transverse fascia.”

“Head sloping downward anteriorly, first antennal segment almost attaining apex of tylus. Head length 0.94, width 1.52, interocular space 0.96. Anterior pronotal lobe swollen, strongly elevated above posterior lobe with width greater than that across humeral angles. Anterior pronotal lobe length 0.90, width 1.22, posterior pronotal lobe length 0.62, width 1.10. Scutellum small, somewhat elevated mesally. Length scutellum 0.56, width 0.62. Claval commissure length 0.62. Hemelytra strongly constricted mesally, narrowest at level of distal end of claval commissure. Membrane attaining middle of abdominal tergum 7. Midline distance from apex of clavus to apex of corium 1.00. Midline distance from apex of corium to apex of abdomen 1.82. Abdomen strongly constricted basally. Middle and hind femora enlarged. Fore femora incrassate, a sharp spine present on venter at distal one-third. Plectron an elevated group of short tubercles ventrally on proximal one-third of femora. Head stridulitrum elevated. Metathoracic scent gland auricle straight, evaporative area very large occupying entire anterior lobe of metapleuron. Labium extending at least to middle of mesosternum. Labial segment lengths I 0.46, II 0.50, III 0.40, IV 0.50.

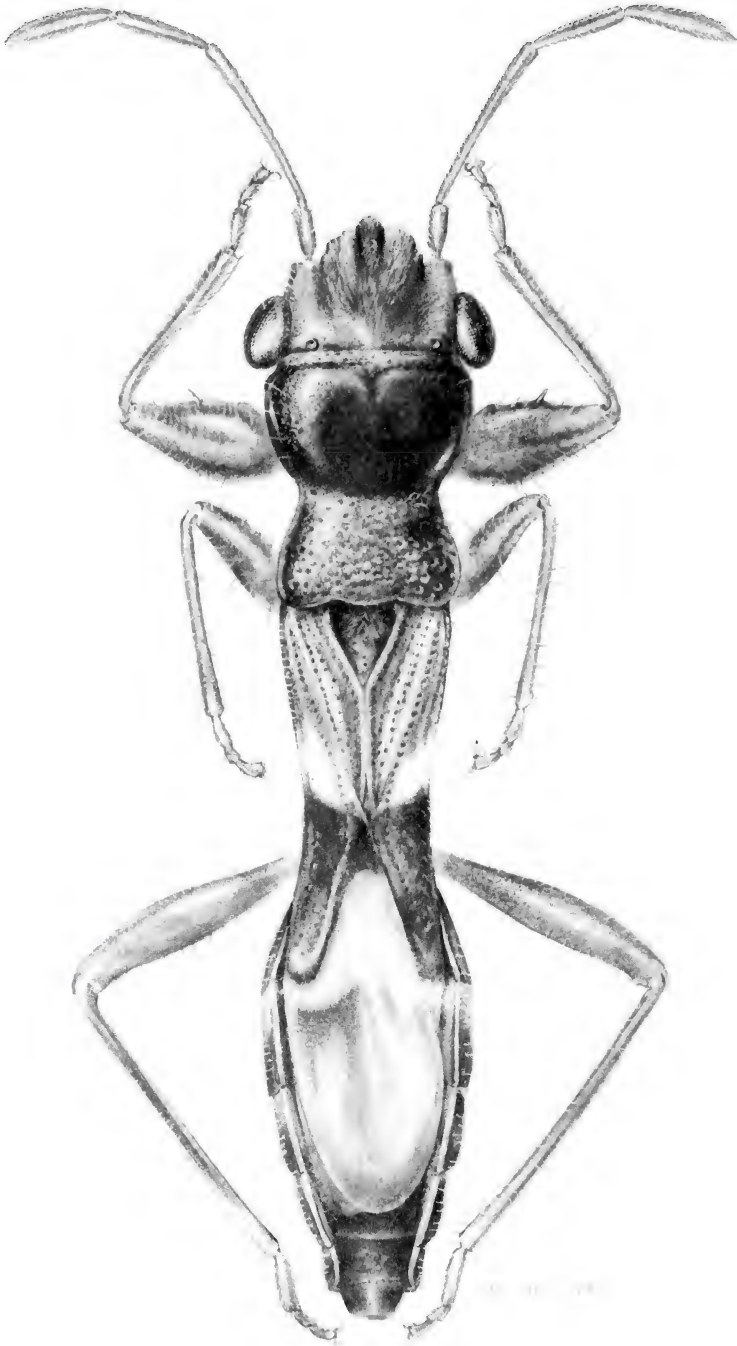


Fig. 14. Dorsal illustration of *Cattarus stysi* Slater (After Slater, 1999).



Figs. 15, 16. Photographs of *Cattarus stysi* Slater. 15, adult ♂, dorsal aspect. 16, adult ♂, lateral aspect.

Antennae stout, segments three and four fusiform. Antennal segment lengths I 0.30, II 1.16, III 0.70, IV 0.80. Total body length 6.40.”

Discussion. The description of this species was based on a male and a female from Minas Gerais, Brazil, Viçosa, Corrego de Paraíso (Mata do Prefeitura), 10.iii.1993, T. J. Henry coll. (Holotype male in MNRJ; paratype female in NMNH).

The junior author, collector of the type series, noted that the erratic behavior of the specimens in the field closely resembled that of wingless hymenopterans, not too unlike ponerine ants.

Parapamphantus erikae Brailovsky

Figs. 17, 18

Parapamphantus erikae Brailovsky 1989:197; Slater and O'Donnell 1995: 72.

Discussion. This species, previously known only from Brazil, belongs in the tribe



17

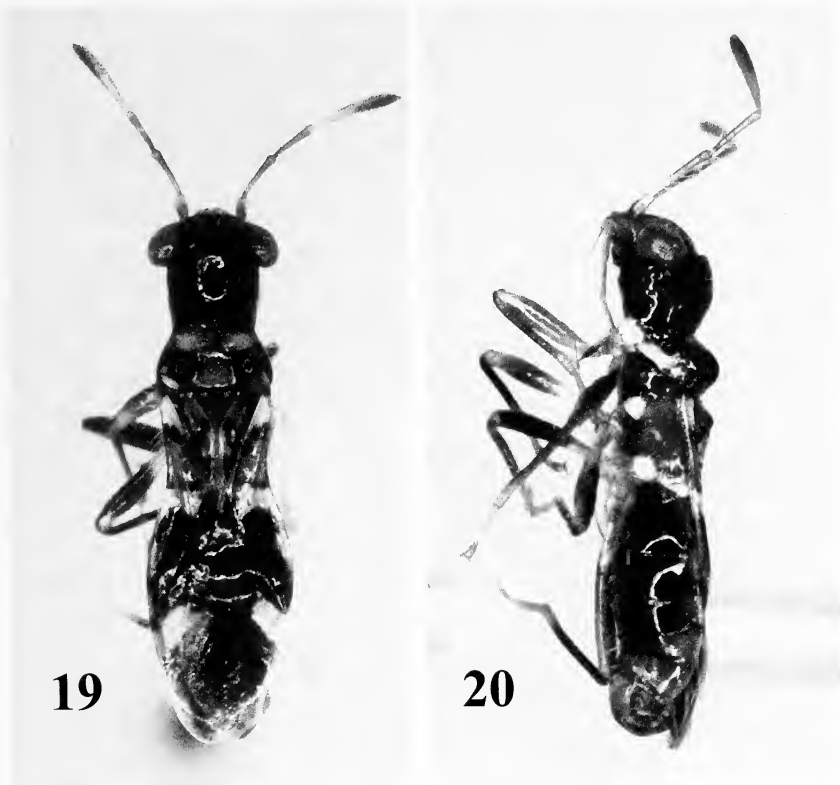


18

Figs. 17, 18. Photographs of *Parapamphantus erikae* Brailovsky. 17, adult ♀, dorsal aspect. 18, adult ♀, lateral aspect.

Pamphantini. The following specimens represent new country records for Ecuador and Venezuela.

Additional locality records. ECUADOR, **Napo:** 6 ♂♂, 10 ♀♀, Res. Ethnica Waorani, 1 km S. Onkone Gare Camp, Trans. Ent. 8, 12, and 20, i.1994–ii.1995, 220 m, 00°38'S, 76°26'W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves, some with covering of lichenous or bryophytic plants in terre firme forest, at 10X-trans, 42 m mark, Proj. MAXUS, Lots 572, 615, 617, 619, 745, 924, 951, 953, 909,



Figs. 19, 20. Photographs of *Tropicoparapamphantus amazonicus* Brailovsky. 19, adult ♂, dorsal aspect. 20, adult ♂, lateral aspect.

979, 1005, 1043, 1047 (BNHM, JAS, NMNH). VENEZUELA, **Aragua**: 1 ♀, Rancho Grande, Henry Pittier Natl. Pk., 1100 m, 24.xii.1985, P. Kovarik, R. Jones (TAMU).

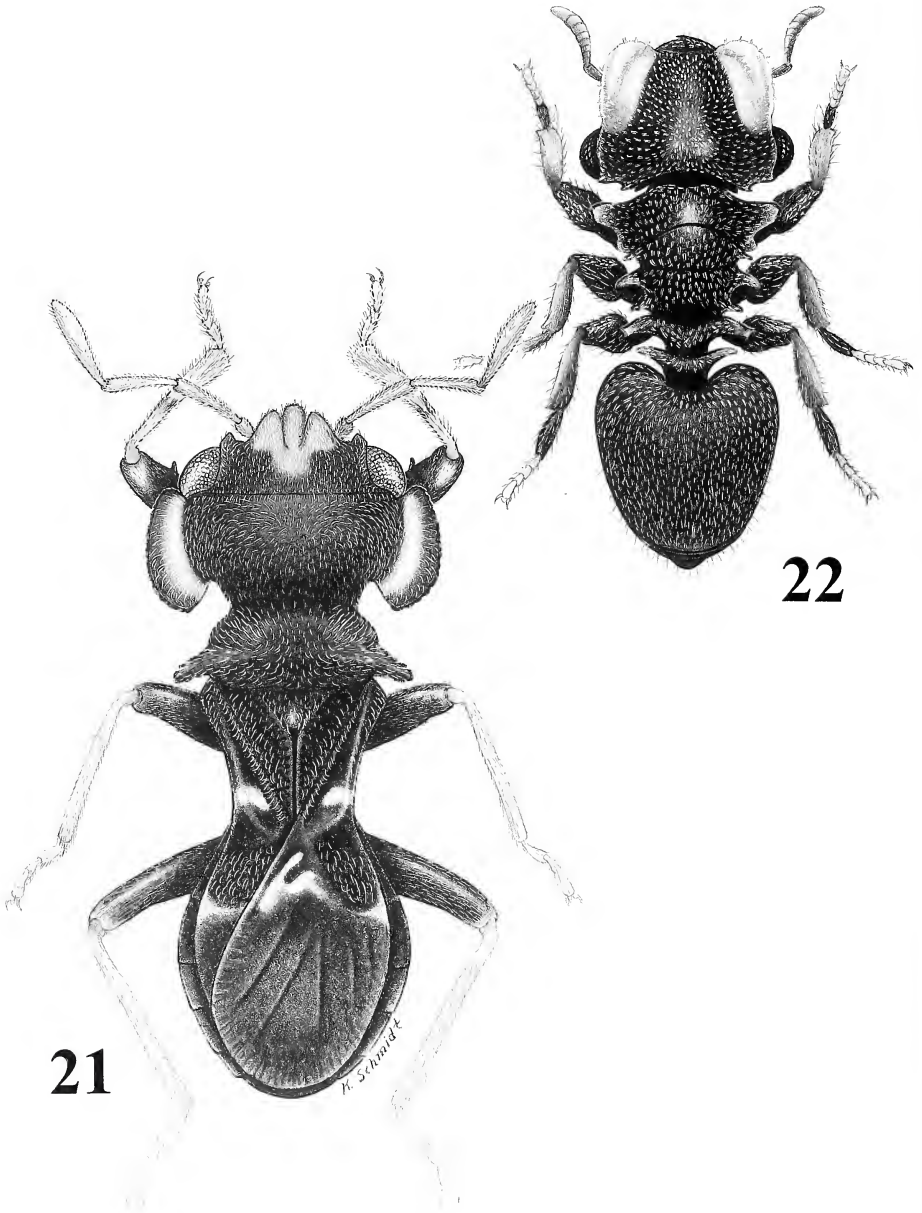
Tropicoparapamphantus amazonicus Brailovsky

Figs. 19, 20

Tropicoparapamphantus amazonicus Brailovsky 1989: 195; Slater and O'Donnell 1995: 73.

Discussion. This species, previously known only from Brazil, belongs in the tribe Pamphantini. The following specimens represent new country records for Ecuador and Peru.

Additional locality records. ECUADOR, **Napo**: 10 ♂♂, 12 ♀♀, 2 nymphs, Res. Ethnica Waorani, 1 km S. Onkone Gare Camp, Trans. Ent. 7, 19, 20, and 24, i.1994, 220 m, 00°38'S, 76°36'W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves, some with covering of bryophytic plants, Project MAXUS at x-trans



Figs. 21, 22. *Cephalocattarus waorani*, n. sp., and hypothesized ant model. 21, Dorsal illustration of *Cephalocattarus waorani*, n. sp. 22, Dorsal illustration of ant *Cephalotes pavonii* (Latreille).

7, 19 m, Lots 6, 604, 608, 612, 628, 642, 643. PERU: 3 ♀♀, Madre de Dios, Rio Tambopata Res., 30 km (air) SW Pto. Maldonado, 290 m, 12°50'S, 69°17'W, Smithsonian Institution canopy fogging project, T. L. Erwin et al. colls., 20.xi.1983 "03/02"; 2 ♀♀, same data except 10.v.1984, "04/03"; 2 ♂♂, 1 ♀, same data except 7.xi.1983, "01/02/072"; 1 ♂, 1 ♀, same data except 4.v.1984, "01/03"; 1 ♂, same data except 30.iv.1984, "03/03" (BNHM, JAS, and NMNH).

Cephalocattarus, new genus

Type species. *Cephalocattarus waorani* Slater and Henry, new species.

Diagnosis. *Cephalocattarus* is distinguished by the broad head, wing-like expansions and humeral spines on the pronotum, conical apical third of the scutellum, strongly constricted abdomen and hemelytra, distinct stridulitrum on the head and prosternum, fore femur incrassate, with a subapical spine, and a blunt tubercle on abdominal segment III of males.

Description. Myrmecomorphic (Figs. 21, 23, 24). Length 4.22 mm. Head nearly two times broader than long (68: 36); eyes reniform, posterior margins touching pronotum; ocelli small, widely placed laterally near eyes in line with outer margins of antennal bases; antenniferous tubercle prominent, tylus (or clypeus) and juga extending anteriorly to apex of antennal segment I; surface coarsely granulate, with sparse, short, sericeous setae; undersurface finely alutaceous, buccula short, rounded posteriorly, ending narrowly at base near distinctly carinate stridulatory apparatus that continues onto the prosternum. Labium four segmented (16: 15: 12: 17), extending to mesosternum just beyond procoxae. Antennal segment I shortest, barrel shaped; segment IV longest, strongly fusiform; segments II and III terete, weakly clavate distally. Pronotum highly modified, bilobed; anterior lobe broadest, deeply constricted at middle connecting to posterior lobe; lateral margins strongly explanate, forming punctate wing-like structures extending anteriorly to become contiguous with eyes; posterior lobe strongly flaring posteriorly from constricted base, each humeral angle with a stout, elongate, lateral spine; scutellum equilateral, base flattened, concealed by transverse base of pronotum, apical third conical, elevated well above level of clavus. Hemelytra weakly flared at base, then strongly narrowing to constricted middle near level of apex of clavus before flaring to cover broadly rounded abdomen; clavus with two parallel rows of deep punctures, corium with a single row of deep punctures bordering clavus and a small cluster of punctures near area of maximum constriction, remainder alutaceous, with short, sparse, sericeous setae; membrane entire with 3 to 5 indistinct veins. Ventral surface impunctate; prosternum with triangular-shaped stridulitrum that meets continuation of stridulitrum on head, extending from anterior margin to a point at proacetabulum. Metathoracic auricle straight, channel distinct, elevated above pleural surface; evaporatorium covering entire metathorax from lateral margin ventrally to carinate midline, and extending anteriorly to cover adjacent border of mesopleuron; dorsal half with deep, widely spaced punctures. Abdomen rounded, bulbous, strongly constricted at base, mostly alutaceous ventrally except for polished segments II and III; spiracles 2–4 dorsal, 5–7 ventral; segments II and III fused, segment III of male with a blunt tubercle on either side about the middle of the posterior margin; a field of fine radiating grooves anterior to tubercle suggests another stridulatory area, in addition to that on head and pros-

ternum. Middle and hind femora enlarged; fore femur incrassate, with a sharp stout ventral spine subdistally; plectron apparently represented by granulate middle $\frac{2}{3}$ of anterior surface; polished basal half of hind femur matching position of polished abdominal segments II and III suggestive of a second plectron.

Etymology. The name is formed from a combination of "Cephalo," the prefix taken from the generic name of the ant, *Cephalotes pavonii* (Latreille), which this new genus resembles because of modified head and thorax, and the generic name *Cattarus*, the type genus of the tribe Cattarini to which it belongs. The gender is masculine.

Discussion. This new genus, despite its strongly modified body structure, belongs in Cattarini and appears closely related to *Cattarus* based on the shared stridulitrum on the head and the distinct tubercle on the male abdominal segment III. Both of these genera also have abdominal spiracles II–IV dorsal and abdominal segments II and III fused and lacking any visible suture.

Cephalocattarus waorani, new species

Figs. 21, 23–25

Description. *Adult male* (Figs. 21, 23, 24): Head, pronotum, and scutellum dull black, except clypeus, juga, basal area surrounding them, and inner half of lateral pronotal wing-like structures brownish orange; eyes rich reddish brown. Labium yellowish brown. Antenna dark brown, segments II–IV more yellowish dorsally and ventrally. Hemelytra flat black, except for a small quadrate fascia at constricted area near level of apex of clavus. Membrane mostly black, narrowly white along area at base bordering apex of corium and on triangular area between coria. Femora mostly fuscous or black; fore femur brownish orange on distal $\frac{1}{4}$; middle and hind femora narrowly brownish orange distally and with a yellowish-white band at base of each; tibiae brownish red, fore femora becoming yellowish brown on anterior face; tarsi and claws yellowish brown to reddish brown. Ventral surface of thorax mostly dull black; fore and middle acetabula white; metathoracic auricle and evaporatorium black. Abdomen black; connexiva IV–VII and lateral margins of ventrites III and V–VII yellowish brown. In general sparsely pubescent, with short, sericeus, silvery setae scattered on head, pronotum, hemelytra, ventral surface of abdomen, propleuron, metathoracic evaporative surface, and underside of head.

Head length 0.70, width 1.32, interocular space 0.90. Anterior pronotal lobe length 0.60, width across wing-like expansions 1.80, posterior pronotal lobe length 0.60, width across humeral spines 1.82. Scutellar length 0.58, width 0.52, height 0.10. Claval commissure length 0.92. Midline distance from apex of clavus to apex of corium 0.64. Midline distance from apex of corium to apex of abdomen 1.20. Labial segment lengths I 0.32, II 0.28, III 0.26, IV 0.32. Antennal segment lengths I 0.16, II 0.50, III 0.40, IV 0.58. Total body length 4.22.

→

Figs. 23–26. *Cephalocattarus waorani*, n. sp., and hypothesized ant model. 23–25, Photographs of *Cephalocattarus waorani*, n. sp. 23, adult ♂, dorsal aspect. 24, adult ♂, lateral aspect. 25, 5th-instar nymph, dorsal aspect. 26, Photograph of ant *Cephalotes pavonii* (Latreille), dorsal aspect.



Fifth-instar nymph (Fig. 25): Head, pronotum, scutellum, and mesothoracic wing pad black. Triangular caudo-lateral angles of pronotum with a V-shaped white vitta on basal one-half. Mesothoracic wing pad with a large, broad crescent-shaped white patch extending from lateral margin to middle of wing pad at level of distal one-third of pad. Abdomen a strongly contrasting pale reddish (probably red in life) with an ovoid black sclerotized median macula extending anteriorly (only) from suture between terga 3–4; a large ovoid black macula mesally between terga 4–5 and a similar but more quadrate one with parallel sided lateral margins between terga 5–6. Both latter maculae much more strongly developed anterior to gland opening but also present posteriorly in contrast to macula between terga 3–4. Abdominal sterna 5–8 with mesal black sclerites covering entire central area of each sternite. Legs dark red brown. Antennal segments two and three bright red, dorsal surface of segment two white.

Head broad, strongly declivent with eyes sessile as in adult. Head length 0.68, width 1.30, interocular distance 0.96. Pronotum broad with flattened lateral expansions (much less well developed than in adult), with a very narrow differentiated posterior lobe laterally produced as a postero-lateral triangular tooth-like projection. Pronotal length 0.96, width 1.54, width across posterior lobe spurs 0.92. Mesothoracic wing pad extending posteriorly onto extreme anterior portion of abdominal tergum three, expanded near base laterally as a large blunt spur. Wing pad length 1.20. Abdomen broadly ovoid, sutures between terga 3–4 and 4–5 moderately curving posteriorly from lateral margins to meson; suture between terga 5–6 strongly curving posteriorly to meson. Black mesal macula of suture 3–4 apparently lacking a scent gland opening, but definite openings present between maculae on terga 4–5 and 5–6. No indication of a Y-suture between terga 3–4. Abdominal length 1.76 (approx.) width across abdomen 1.46. Antenna short and stout, fourth segment strongly fusiform. Antennal segment lengths I 0.18, II 0.40, III 0.34, IV 0.38. Labial segment lengths I 0.36, II 0.32, III 0.32 IV obscured. Total body length 5.28 (approx.).

Etymology. The specific epithet of this new species, a noun in apposition, comes from the name of the native Huaorani or Waorani [pronounced war-on-ee] people, who inhabit the region of Ecuador where the type series was collected.

Discussion. Only three specimens of this species have been discovered so far, but their remarkable resemblance to the ant *Cephalotes pavonii* (Latrielle) (Figs. 22, 26) found in the same canopy-fogging samples of Ocone Gare leaves little doubt that this is the model after which this bug is patterned. The broadly explanate pronotal margins, humeral spines, and constricted hemelytra, along with the black overall coloration accented with brownish-orange on the head, pronotum, and legs, give this catterine an appearance remarkably similar to *Cephalotes pavonii*. Hespenseide (1986) indicated that at least 13 Central American species of *Cephalotes* Latreille (as *Zacryptocerus* Wheeler) also appear to be models for Batesian mimicry for no less than 40 arthropods. According to Creighton (1950), ants of this genus are arboreal or, at least, prefer to nest in twig cavities. Some members of this group are capable of flattening their bodies against a substrate, making them extremely difficult to pick up. This is unlike most arboreal ants that rely on agility to escape danger. Hespenseide (1986) noted that the primary defense of many of these ants appears to be chemical and workers picked up in the field typically give off a strong odor.

The heads of major workers in some species are strongly modified into saucer-like structures that may be used to block nest entrances (Adrade and Urbani, 1999). Kempf (1951) and Adrade and Urbani (1999) redescribed and reported *Cephalotes pavonii* from Brazil, French Guyana, Guyana, Peru, and Suriname. Nothing specific seems to be known about its biology.

Types. Holotype, ♂: ECUADOR: **Napo** [Prov.], Res. Ethnica Waorani, 1 km S. Onkone Gare Camp, Trans. Ent. 9.x.1994, 220 m, 00°39'10"S, 76°25'00"W, T. L. Erwin et al., insecticidal fogging of mostly bare green leaves, some with covering of lichenous or bryophytic plants in terre firme forest at Trans. 6, Sta. 3, Lot 922 (held in trust at NMNH). Paratypes: 1 ♀, 2 ♂♂, same data as for holotype, except ii.1995 at Trans. 8, 10, & 11, Sta. 5, Lots 964, 1007, 1009, & 1023 (JAS and NMNH).

Additional material examined. ECUADOR, **Napo**: 1 fifth-instar nymph (described above), data same as for holotype, except ii.1995 at Trans. 8., Sta. 10, Lot 1009 (NMNH).

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We are grateful to T. L. Erwin (Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. [NMNH]) for the many Pamphantinae collected through his canopy-fogging studies that were used in this study; J. C. Schaffner (TAMU) for lending specimens; and to M. E. Webb (BNHM) for lending the lectotypes of *Phaeax balteatus* and *P. formicarius*. We also thank D. R. Smith (Systematic Entomology Laboratory, PSI, ARS, USDA, % NMNH [SEL]) for literature on and the identification of the model ant *Cephalotes pavonii*; G. G. E. Scudder (Dept. Entomology, University of British Columbia, Vancouver) for permission to use the Arthur Smith drawing of *Phaeax formicarius*; Mary Jane Spring (Storrs, Connecticut) for the drawing of *Cattarus styasi*; and Kathleen Schmidt (Hillsdale, New York) for the illustrations of the new bug *Cephalocattarus waorani* and the ant *Cephalotes pavonii*. R. C. Froeschner (NMNH), D. R. Smith, and N. J. Vandenberg (SEL) kindly reviewed the manuscript and offered suggestions for its improvement.

LITERATURE CITED

- Andrade M. L. de and C. B. Urbani. 1999. Diversity and adaptation in the ant genus *Cephalotes*, past and present. Stuttgart Beitrge zur Naturkunde, Serie B (Geologie und Palontologie) 271:1–889.
- Barber, H. G. and S. C. Bruner. 1933. A new subfamily of Lygaeidae, including a new genus and two new species of *Pamphantius* Stl. [Hemiptera-Heteroptera: Lygaeidae]. Journal of the New York Entomological Society 41:531–542.
- Brailovsky, H. 1989. Un gnero y dos especies nuevas de hemipteros (Lygaeidae, Bledionotinae, Pamphantini) del Brasil. Anales de Instituto de Biologia Universidad Nacional Autnoma Mexico, Ser. Zool. 59(2):193–202.
- Creighton, W. S. 1950. The ants of North America. Bulletin of the Museum of Comparative Zoology. 104:1–585.
- Distant, W. L. 1890–1893. Insecta. Rhynchota. Hemiptera-Heteroptera. Volume I. Biologia Centrali-Americana, London. x + 462 pp, 39 pls. [1880: 1–88; 1881: 89–168; 1882: 169–224; 1883: 225–264; 1884: 265–304; 1889: 305–328; 1893: i–xx + 329–462].
- Henry, T. J. 1997. Phylogenetic analysis of family groups within the infraorder Pentatomomorpha (Hemiptera: Heteroptera), with emphasis on the Lygaeoidea. Annals of the Entomological Society of America 90:275–301.

- Hespenheide, H. A. 1986. Mimicry of ants of the genus *Zacryptocerus* (Hymenoptera: Formicidae). J. New York Entomological Society 94:394–408.
- Hussey, R. F. 1929. Fascicle III. Pyrrhocoridae, pp. 1–113 (Bibliography, pp. 114–137, by E. Sherman) in G. Horváth and H. M. Parshley (eds.), General Catalogue of the Hemiptera. Smith College, Northampton, Massachusetts.
- Kempf, W. W. 1951. A taxonomic study on the ant tribe Cephalotini (Hymenoptera: Formicidae). Revista de Entomologia, Rio de Janeiro 22:1–244.
- Scudder, G. G. E. 1963. Pamphantinae, Bledionotinae and the genus *Cattarus* Stål (Hemiptera: Lygaeidae). Opuscula Entomologica 28:81–89.
- Slater, J. A. 1964. A Catalogue of the Lygaeidae of the World. 2 volumes. University of Connecticut, Storrs. 1688 pp.
- Slater, J. A. 1999. The Systematic position of the Pamphantinae with the description of two new tribes and a new species of *Cattarus* Stål (Hemiptera: Lygaeoidea: Geocoridae). Acta Societatis Zoologicae Bohemicae 63:199–208.
- Slater, J. A. and J. E. O'Donnell. 1995. A Catalogue of the Lygaeidae of the World (1960–1994). New York Entomological Society, New York. 410 pp.
- Stål, C. 1860. Bidrag till Rio Janeiro-traktens Hemipter-fauna. Kongliga Svenska Vetenskaps-Akademiens Handlingar 2(7):1–84.
- Woodward, T. E. 1962. *Phaeax* Distant transferred from Pyrrhocoridae (Larginae) to Lygaeidae (Hemiptera: Heteroptera). Proceedings of the Royal Entomological Society of London (Series B)31:122–126.

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NAUCORIDAE (HETEROPTERA) OF NEW GUINEA. 6. A REVISION OF THE GENERA *SAGOCORIS* AND *APTINOCORIS*, WITH DESCRIPTIONS OF NEW SPECIES

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Abstract.—The taxonomy of the creeping water bugs belonging to the genera *Sagocoris* and *Aptinocoris*, which are endemic to New Guinea and nearby islands, is revised. The following new species are described: *Sagocoris intermedius* from central Irian Jaya, *Sagocoris irianus* from northern Irian Jaya, *Sagocoris flavinotum* from northern Irian Jaya, *Aptinocoris sogeri* from southeastern Papua New Guinea, *Aptinocoris minutus* from northern Papua New Guinea, *Aptinocoris boikiki* from northeastern Papua New Guinea, and *Aptinocoris ziwa* from northern Irian Jaya. The following new generic assignments are proposed (new combinations given second): *Sagocoris fenneri* = *Aptinocoris fenneri*; *Sagocoris sedlaceki* = *Aptinocoris sedlaceki*; *Sagocoris cheesmanae* = *Aptinocoris cheesmanae*; *Quadricoris asymmetrica* = *Sagocoris asymmetricus*. The following new synonyms are proposed (junior synonyms listed first): *Quadricoris* La Rivers = *Sagocoris* Montandon; *Truncocoris* La Rivers = *Aptinocoris* Montandon; *Sagocoris browni* La Rivers = *Aptinocoris papuus* Montandon. The supergenera *Margodes* and *Margallus* proposed by La Rivers are considered invalid names since they refer to a taxonomic category that has no official status under the present Code. Illustrations are provided for the male genital structures and female pregenital structures for all *Sagocoris* and *Aptinocoris* species, along with maps detailing the distributions of these species within New Guinea.

The creeping water bugs belonging to the genera *Sagocoris* and *Aptinocoris* are common components of the benthos in many New Guinea streams at elevations below 1,200 m. In appearance, they are reminiscent of members of the Neotropical tribe Ambrysini, and appear to fill similar ecological roles. These groups were treated by La Rivers (1971) in his monograph of the Papuan Naucoridae, but since that time a number of new species have been discovered, and new character systems have been investigated, particularly in the male genitalia, that offer more useful characters for species separation than those employed in La Rivers' (1971) keys.

NOMENCLATURAL HISTORY

The monotypic genus *Aptinocoris* was erected by Montandon (1897) to hold the species *A. papuus* based on a specimen collected by Oduardo Beccari at Hatam in the Arfak Mountains of the Vogelkop Peninsula, in northwestern New Guinea. Although Montandon (1897) stated that his holotype of *A. papuus* was deposited in the Genoa Museum, this did not come to the notice of either Robert L. Usinger or Ira La Rivers, who initiated the first major revisional work on the Papuan naucorid fauna. Following Usinger's untimely death, La Rivers (1971) completed this revision, but without examining the actual holotype of *A. papuus*, instead basing his generic interpretation of *Aptinocoris* on a single specimen from Sattleberg in the Huon Pen-

insula of Papua New Guinea, determined by Montandon as a "*A. papuus* var." This led La Rivers (1971) to misinterpret the genus concept, and to describe several new species in the related genus *Sagocoris* that should actually have been placed within *Aptinocoris*.

The genus *Sagocoris* was proposed by Montandon (1911) to hold *S. biroi* from the "Montagnes Hansmann, Baie de L'Astrolabe," a locality near present day Madang in northeastern New Guinea. La Rivers in his (1971) revision divided this genus into two subgenera, *Sagocoris* and *Truncocoris*. The latter subgenus contained those species with a slightly more elongate body form, non-spinose connexival angles, and posteriorly truncate hemelytra in brachypterous forms. The species grouped in this assemblage are in fact those referable to Montandon's *Aptinocoris*, and *Truncocoris* is therefore synonymized under *Aptinocoris* herein. The remaining species grouped by La Rivers' (1971) in his subgenus *Sagocoris* are those which actually conform to Montandon's genus concept of *Sagocoris sensu strictu*, having a broadly ovate body form, spinose connexival angles, and posteriorly angulate hemelytra in brachypterous forms.

In this same revision La Rivers (1971) erected three additional monotypic Papuan genera, *Quadricoris*, *Cavocoris*, and *Warisia*, that bear morphological similarities to *Aptinocoris* and *Sagocoris*. The basic character used to separate *Quadricoris* from *Sagocoris* was the ventral abdominal asymmetry in the former genus. The asymmetry in *Quadricoris*, while pronounced, is in fact only an extreme expression of a similar trend seen in many species of *Sagocoris*, and does not appear to form sufficient basis for a generic separation. As a result *Quadricoris* is herein synonymized under *Sagocoris*. The genus *Cavocoris* was revised by Polhemus and Polhemus (1989), who considered the genus valid, described additional species, amplified on La Rivers (1971) generic diagnosis, and provided character comparisons to other related endemic Papuan genera. The genus *Warisia* is a distinctive taxon that was discussed in passing by Polhemus and Polhemus (1989) in relation to its affinities with *Cavocoris*. Only a single species, *W. cavanceps* La Rivers is presently known, but a reanalysis of genitalic characters may prove that several species are in fact represented in different parts of New Guinea.

The five above genera were united by La Rivers (1971) into a new tribe Sagocorini, which he subdivided into two "supergenera," *Margodes* and *Margallus*. The supergenus category has no formal standing under the present Code of Zoological Nomenclature, and the two above names are herein considered unavailable, following the opinion of Stys and Jansson (1988). The defining characters given by La Rivers (1971) for his Sagocorini in relation to other cheirochelinae were the absence of "static sense organs" and "antennal grooves," the possession of an ovate body shape, and the presence 2–6 transverse rows of spines at the distal end of the middle tibia. With the possible exception of the last character these are all plesiomorphic states within Naucoridae, and thus not sufficient to define the Sagocorini in a phylogenetic sense. In addition, certain of the above characters were misinterpreted by La Rivers, since his "static sense organs" are present on the anterior propleura of all known species of *Aptinocoris* (Fig. 37). The endemic complex of Papuan naucorid genera as a whole appears to represent a monophyletic radiation from a single ancestral stock, forming an evolutionary continuum, so that the monophyly or paraphyly of the tribe Sagocorini in relation

to its putative sister tribe, the Tanycrisini, is not firmly established. These questions of higher level classification are beyond the scope of the current revision, and will be dealt with in a subsequent study examining the cladistic relationships of the New Guinea naucorids as a whole.

METHODS

All measurements in the descriptions below are given in millimeters. The width of the head refers to the width as measured across the eyes; the width of an eye is the greatest width measured perpendicular to the longitudinal axis of the head. The anterior/posterior interocular measurement refers to the shortest distances between the eyes at their anterior and posterior ends respectively as viewed from directly above.

Descriptions, particularly of color, were made from dry pinned specimens. Certain structural characters given in the generic descriptions hold constant across all species, and as such are not repeated in the individual species descriptions.

Male genitalia were analyzed by removing the genital capsule, then dissecting away the parameres to reveal the phallosoma, which was figured *in situ* from the top. The views of the parameres presented represent dorsal views of these structures as they appear when at rest in the genital capsule.

CL numbers following locality data refer to codes used by the authors to reference ecological notes. Localities in the material examined sections have been assigned to their modern Indonesian provinces, even though these data are usually not present on the original labels of older specimens. Labels reading "Dutch New Guinea" have thus been listed under "Indonesia, Irian Jaya Province." In addition, since place names have changed considerably in the Indonesian half of New Guinea over the past several decades modern place name equivalents (where known) have been added in brackets to aid in interpretation of older label data.

The notation "PTFI" in the material examined sections refers to the P. T. Freeport Indonesia mining company, which provided logistical support for surveys in remote areas of Irian Jaya. On the distribution maps, localities in close proximity to each other are represented by a single symbol.

KEY TO THE GENERA OF SAGOCORINI

1. Anteclypeus with distinct notch above base of labrum (Fig. 3); male left paramere usually greatly reduced in comparison to right 2
- Anteclypeus lacking distinct notch above base of labrum, anterior margin forming a smooth uninterrupted lip; male left paramere often similar in size to right 3
2. Hemelytra in brachypterous forms truncate posteriorly (Fig. 36); anterolateral angle of propimeron with depressed patch of fine gold setae (Fig. 37) . . . *Aptinocoris* Montandon
- Hemelytra in brachypterous forms angulate posteriorly (Fig. 5); anterolateral angle of propimeron lacking a depressed patch of fine gold setae *Sagocoris* Montandon
3. Hydrofuge pile of abdominal venter dark in coloration; anteclypeus with a pair (1+1) of shallow depressed pits to either side of midline flanking base of labrum; female abdominal paratergite III lacking deep pit; male left paramere not markedly reduced in size compared to right *Warisia* La Rivers
- Hydrofuge pile of abdominal venter shining gold in coloration; anteclypeus lacking a pair of shallow depressed pits to either side of midline; female abdominal paratergite

III often bearing a deep pit; male left paramere frequently reduced in size compared to right *Cavocoris* La Rivers

KEY TO SPECIES OF *SAGOCORIS* MONTANDON

Note: this key employs external characters, primarily of brachypterous females. Males are best identified by dissection of the genital capsule and comparison with the figures provided. Macropterous forms are best identified by association with sympatric brachypterous morphs, which are usually far more common, or by comparison of the male and female genital and pregenital structures to the figures provided.

- 1. Posterolateral angles of pronotum in brachypterous forms coming to small, sharp acute points (Fig. 2) 2
- Posterolateral angles of pronotum in brachypterous forms rounded, not forming small, sharp acute points 3
- 2. Small species, overall length less than or equal to 9.0 mm; apex of female subgenital plate with multiple indentations (Fig. 19) *S. lariversae* La Rivers
- Larger species, overall length greater than 10.0 mm; apex of female subgenital plate with a single broad, shallow indentation (Fig. 24) *S. irianus* n. sp.
- 3. Female abdominal paratergites obviously asymmetrical, prolonged on left side (Figs. 18, 20, 21) 5
- Female abdominal paratergites symmetrical or nearly so, not prolonged on left side (Figs. 22, 28) 4
- 4. Posterior margin of female subgenital plate broadly concave medially (Fig. 28) *S. flavinotum* n. sp.
- Posterior margin of female subgenital plate rising to a small projection medially, the tip of this projection narrowly concave (Figs. 22, 23) *S. gressitti* La Rivers
- 5. Female abdominal paratergites strongly asymmetrical, forming elongate caudal projections (Figs. 18, 20) 6
- Female abdominal paratergites only weakly asymmetrical, not forming elongate caudal projections (Fig. 21) *S. intermedius* n.sp.
- 6. Female abdominal paratergite V massively expanded, forming a caudal projection surpassing tips of other segments; subgenital plate narrowed on distal half (Fig. 20) ... *S. asymmetricus* (La Rivers)
- Female abdominal paratergite V not prolonged; abdominal paratergite VI elongate, forming a caudal projection surpassing tips of other segments; subgenital plate broadly trapezoidal, not narrowed on distal half (Fig. 18) *S. biroi* Montandon

KEY TO SPECIES OF *APTINOCORIS* MONTANDON

Note: This key employs external characters, primarily of females. Males are best identified by dissection of the genital capsule and comparison with the figures provided. As with *Sagocoris* species, the macropterous forms are best identified by association with the more common brachypterous forms, or by comparison of the male and female genital and pregenital structures to the figures provided.

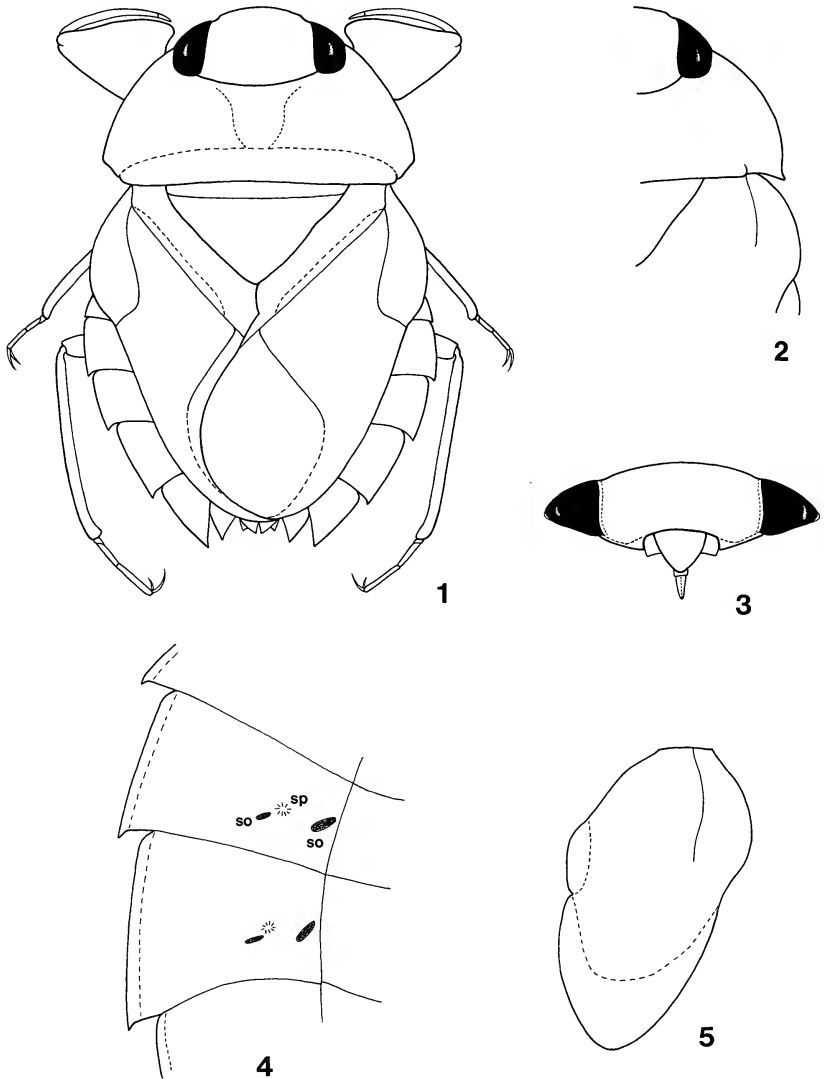
- 1. Female abdominal paratergites asymmetrical, posterolateral angles more greatly produced on left side than right (Figs. 61, 63, 65, 66) 2
- Female abdominal paratergites not asymmetrical, equally produced on both sides (Figs. 62, 64, 67, 70) 6
- 2. Female abdominal paratergites with asymmetrical angles on left side thick and robust (Figs. 63, 65) 3

- Female abdominal paratergites with asymmetrical angles on left side forming slender caudal projections (Figs. 61, 66) 5
- 3. Male right paramere with distal section slightly expanded (Figs. 57, 60); male phallosoma with tip massive and rounded, not folded and angulate (Figs. 56, 59); body length usually equal to or exceeding 7.5 mm; female subgenital plate with shallow concavity at tip (Figs. 63, 65) 4
- Male right paramere with distal section slender, not expanded (Fig. 54); male phallosoma with tip folded and angulate (Fig. 53); body length usually less than or equal to 7.5 mm; female subgenital plate with moderately pronounced concavity at tip (Fig. 64) *A. papuus* Montandon
- 4. Subgenital plate elongate, tip narrowly concave (Fig. 65); New Guinea *A. sedlaceki* (La Rivers)
- Subgenital plate truncate, tip broadly concave (Fig. 63); Waigeo Island *A. cheesmanae* (La Rivers)
- 5. Large species, overall length greater than or equal to 10.0 mm *A. boikiki* n.sp.
- Smaller species, overall length less than 9.0 mm *A. fenneri* (La Rivers)
- 6. Very small species, overall length less than or equal to 6.25 mm *A. minutus* n.sp.
- Larger species, overall length greater than or equal to 6.90 mm 7
- 7. Moderately small species, overall length less than 8.50 mm; form elongate, ratio of body length/width = 1.87/1.00 or greater 8
- Large species, overall length greater than or equal to 10.00 mm; form robust, ratio of body length/width = 1.66/1.00; female subgenital plate as in Fig. 67 *A. sogeri* n.sp.
- 8. Body length 7.0 mm or less; hemelytron with embolar furrow almost straight and nearly parallel to hemelytral margin, posterior width of embolium less than 1.5 times the basal width (Fig. 68); female subgenital plate as in Fig. 70 *A. ziwa* n. sp.
- Body length exceeding 7.0 mm; hemelytron with embolar furrow curving inward and away from hemelytral margin posteriorly, posterior width of embolium over 2.00 times the basal width (Fig. 69); female subgenital plate as in Fig. 64 ... *A. papuus* Montandon

Sagocoris Montandon, 1911

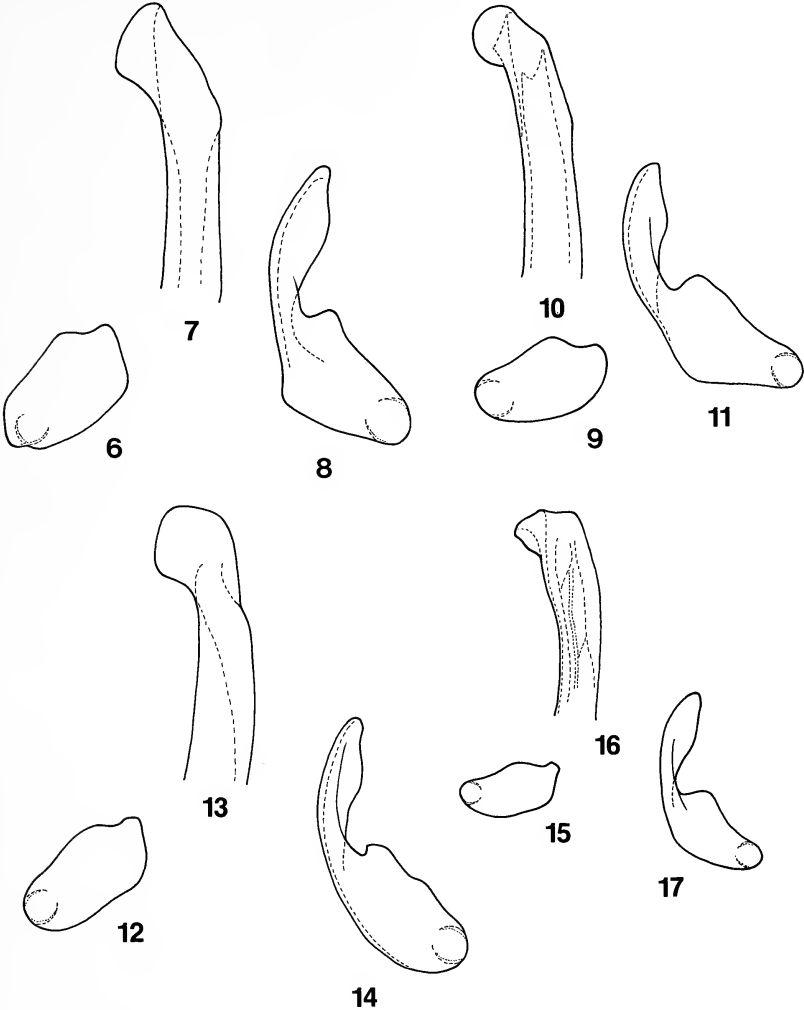
Figs. 1–35

Description. Moderate sized, ovate naucorids (Fig. 1), length 7.50–13.75; basic coloration dull yellowish brown with scattered dark brown or black markings. Brachypterous forms predominating. *Head* dark yellowish brown, with paired longitudinal stripes medially to either side of midline; eyes with dorsal surfaces not rising above plane of vertex, inner margins weakly convergent anteriorly, separated from vertex by shallow furrows, lateral flanges small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance much less than length of labrum, with obvious notch above labral base (Fig. 3); labrum roughly triangular, rounded distally, yellowish brown; maxillary plates moderately developed, inner margins adjoining rostral cavity oriented vertically, anterior margins glabrous, carinate, forming sides of rostral cavity; rostrum extending beyond labrum; antennae 4 segmented, slender, segments III and IV filiform, not extending beyond eye margins. *Pronotum* usually dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, lateral margins broadly rounded, posterolateral angles acutely rounded, posterior margin bisinuate. *Scutellum* generally dark brown, lateral margins very weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* usually dark



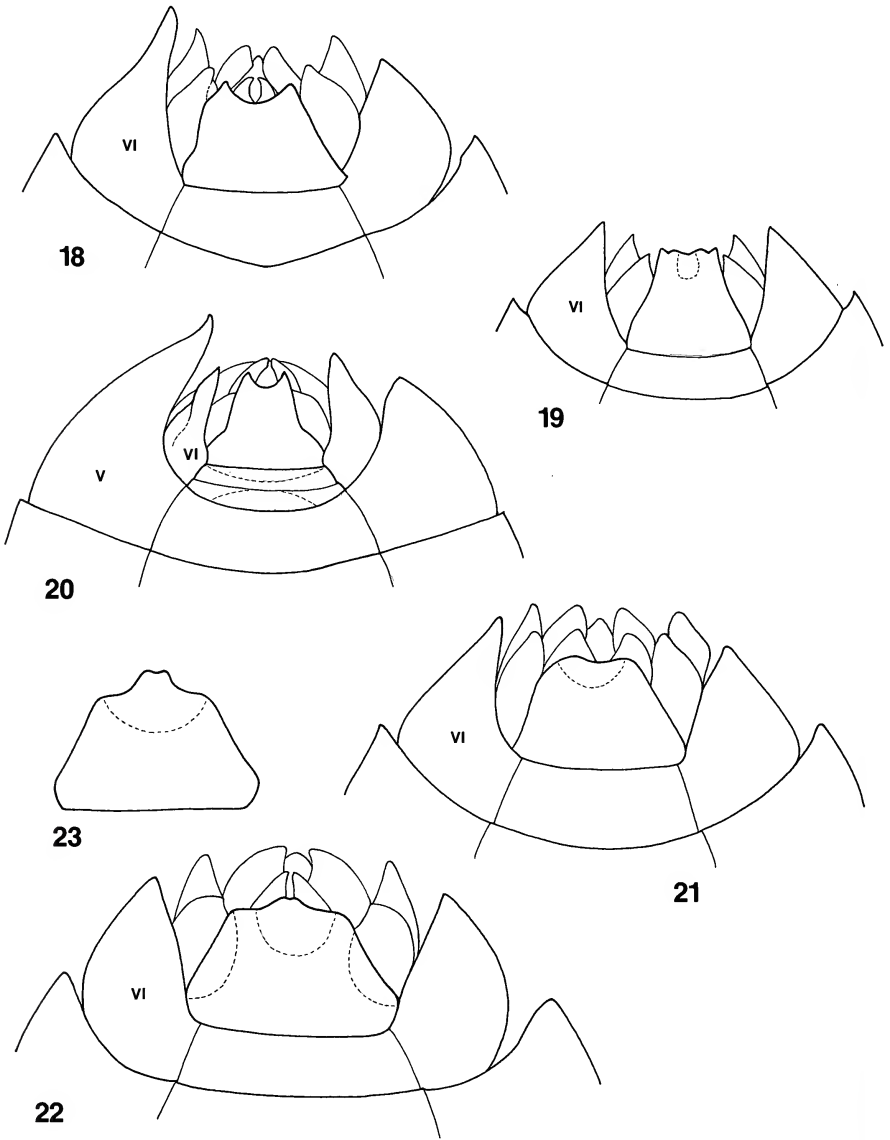
Figs. 1–5. *Sagocoris lariversae* La Rivers. 1. Macropterous female, dorsal habitus. 2. Detail of brachypterous female pronotum, showing more spinose posterolateral angle in this morph. 3. Head, anterior view. 4. Abdominal paratergites III and IV, showing locations of spiracles (sp) and paired, elongate glabrous patches hypothesized to be hydrostatic sensory organs (so). 5. Right wing pad of brachypterous adult.

brown, surface of corium coarsely rugose, membrane reduced, obscure, tips of hemelytra acutely rounded (Fig. 5), extending to base of genital segment; embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold

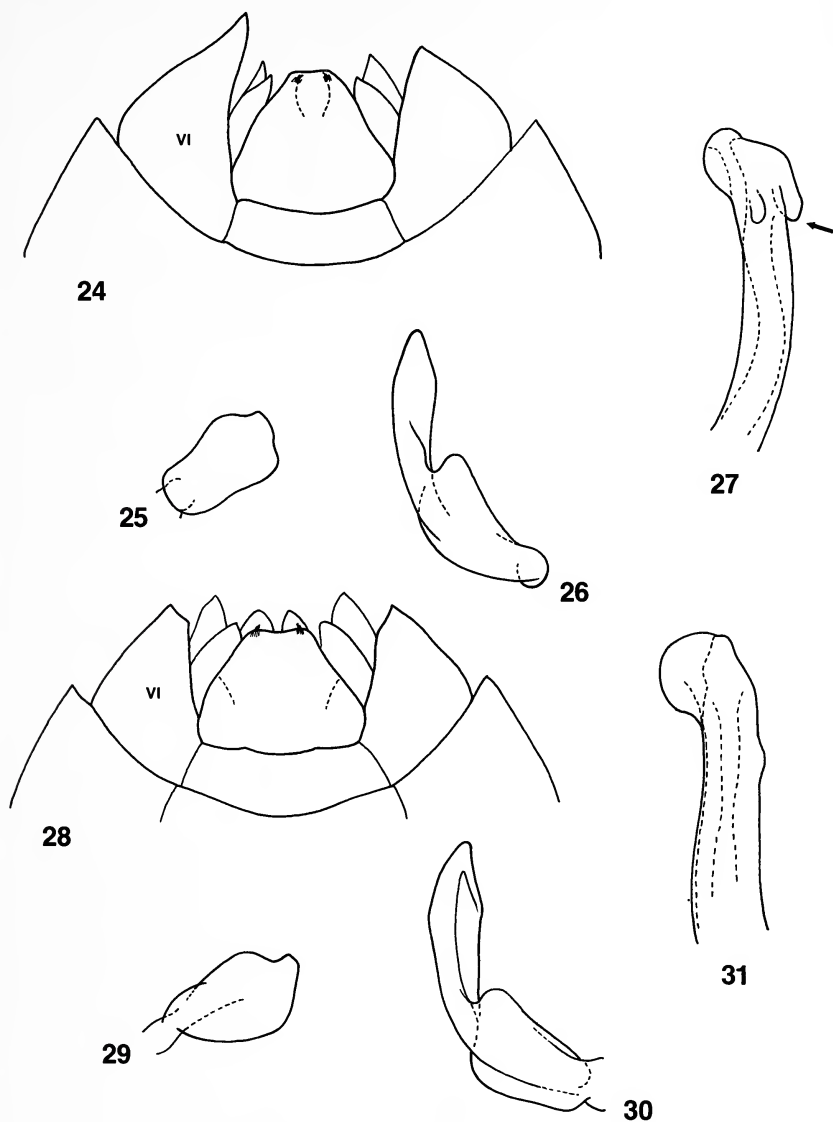


Figs. 6–17. Male genitalia of *Sagocoris* species (all structures in dorsal view, as seen when at rest in genital capsule). Figs. 6–8, *S. gressitti*. 6. Left paramere. 7. Phallosoma. 8. Right paramere. Figs. 9–11, *S. biroi*. 9. Left paramere. 10. Phallosoma. 11. Right paramere. Figs. 12–14, *S. intermedius*. 12. Left paramere. 13. Phallosoma. 14. Right paramere. Figs. 15–17, *S. lariversae*. 15. Left paramere. 16. Phallosoma. 17. Right paramere.

setae; hemelytral commissure with small triangular tab on left hemelytron fitting into corresponding triangular indentation on right hemelytron. *Abdomen* with lateral portions of segments II–VIII exposed when viewed dorsally; posterolateral angles of segments II–IV moderately produced and spinose; angles of segments V–VII in females often becoming asymmetrical to varying degrees, sometimes strongly so, with posterolateral angles more highly produced on left side (Figs. 18–22). *Ventral*



Figs. 18–23. Ventral views of terminal female abdominal structures in *Sagocoris* species, with the relative positions of paratergites V and/or VI indicated. 18. *S. biroi*. 19. *S. lariversae*. 20. *S. asymmetricus*. 21. *S. intermedius*. 22. *S. gressitti*, specimen from Wau, Morobe Province. 23. *S. gressitti*, subgenital plate of specimen from Eio Creek, Central Province, showing intra-specific variation.



Figs. 24–27. *Sagocoris irianus*, male genital and female pregenital structures. All male structures shown in dorsal view, as seen when at rest in genital capsule. 24. Terminal female abdominal structures, ventral view, with relative position of paratergite VI indicated. 25. Male left paramere. 26. Male right paramere. 27. Male phallosoma (arrow indicates position of lightly sclerotized preapical lobes).

Figs. 28–31. *Sagocoris flavinotum*, male genital and female pregenital structures. All male structures shown in dorsal view, as seen when at rest in genital capsule. 28. Terminal female abdominal structures, ventral view, with relative position of paratergite VI indicated. 29. Male left paramere. 30. Male right paramere. 31. Male phallosoma.

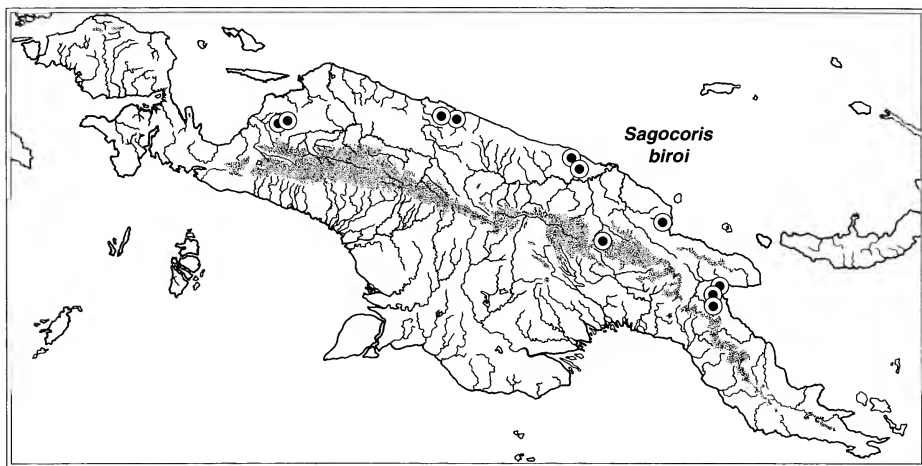


Fig. 32. Distribution of *Sagocoris biroi* in New Guinea.

surfaces of head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; head with glabrous median longitudinal keel, this becoming more pronounced posteriorly, meeting similar and continuous but more pronounced structure on prosternum; proepimeron densely covered with very short fine recumbent gold setae, inner proepimeral projections not touching medially; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially; abdominal paratergites III–VI with paired elongate glabrous openings in the hydrofuge pile adjacent to spiracle (Fig. 4), spiracle represented by small raised protuberance thickly covered with gold hydrofuge setae, paratergites II, VII and VIII each with single glabrous openings, all paratergites with lateral margins narrowly glabrous; hydrostatic sense organs not evident on proepimeron. *Legs* usually dark yellowish; anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face, anterior tarsi single segmented, claw tiny, obscure, single, fused to tarsus; middle and hind coxae each bearing single glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent, parempodia setiform. *Male genitalia* with parameres asymmetrical (Figs. 6, 8, 9, 11, 12, 14, 15, 17, 25, 26, 29, 30); left paramere greatly reduced, blunt; right paramere larger, curving, distal arm constricted basally,



Fig. 33. Distribution of *Sagocoris gressitti* in New Guinea.

expanded apically; male phallosoma with tip expanded, generally lacking lightly sclerotized preapical lobes (Figs. 7, 10, 13, 16, 31), except in *S. irianus* (Fig. 27). *Female subgenital plate* roughly trapezoidal, sometimes weakly asymmetrical, posterior margin medially concave, often broadly so (Figs. 18–22, 24, 28).

Macropterous forms. Similar to brachypterous forms in general structure and coloration, with following exceptions: pronotum slightly expanded, posterolateral angles rounded; scutellum raised, tumescent; hemelytra with claval and embolar sutures well defined (Fig. 1); membrane fully developed, reaching to base of genital segment, lacking evident venation.

Discussion. The shape of both the left and right parameres is relatively conservative among *Sagocoris* species and offers only moderately useful characters for species separation. The shape of the sclerotized structures at the tip of the phallosoma is much more diagnostic (Figs. 7, 10, 13, 16, 27, 31), and is distinctive for each species, as is the shape of the female subgenital plate (Figs. 18–22, 24, 28).

Sagocoris biroi Montandon

Figs. 9–11, 18, 32

Sagocoris biroi Montandon, 1911: 248.

Diagnosis. This moderate sized species may be recognized by the highly asymmetrical prolongation of left side of abdominal paratergites VI and VII in females (Fig. 18), and by the structure of the male parameres and phallosoma (Figs. 9–11).

Material examined. PAPUA NEW GUINEA, **East Sepik Prov.:** 14 brachypterous males, 11 brachypterous females, 5 immatures, waterfall and rainforest stream near Pasam, 10 September 1983, CL 1798, J. T. and D. A. Polhemus (JTPC); 3 macropterous males, 3 macropterous females, 11 brachypterous males, 6 brachypterous females, trib. to Yemogu Creek, nr. Yaugiba, 12 September 1983, CL 1804, J. T. and D. A. Polhemus (JTPC). **Morobe Province:** 2 macropterous males, 1 macropterous

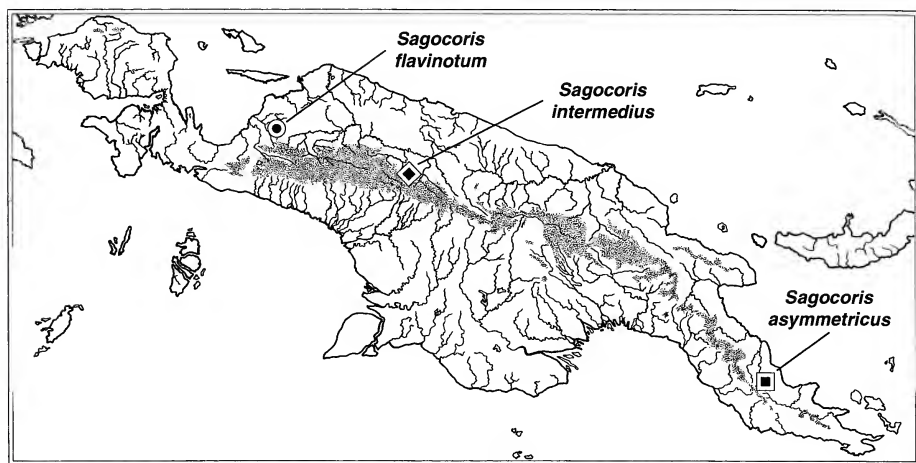


Fig. 34. Distribution of *Sagocoris* species New Guinea.

female, 30 brachypterous males, 54 brachypterous females, 2 immatures, Oomsis, 35 km SW of Lae, 14 September 1983, CL 1810, J. T. and D. A. Polhemus (JTPC); 3 brachypterous females, stream 39 km SW of Lae along Wau Road, 15 September 1983, CL 1812, J. T. and D. A. Polhemus (JTPC); 18 brachypterous males, 12 brachypterous females, Perenin River, along Wau Road, 15 September 1983, CL 1813, J. T. and D. A. Polhemus (JTPC); 1 macropterous female, 4 brachypterous males, 3 brachypterous females, stream 17.8 km N of Mumeng, 19 September 1983, CL 1835, J. T. and D. A. Polhemus (JTPC); 130 specimens, males and females, Gabensis, 10 mi W of Lae, 27 June 1969, I. La Rivers (CAS); 1 macropterous female, 40 brachypterous males, 41 brachypterous females, Lae (Oomsis), 12 December 1969, J. H. Sedlacek (BPBM). **Western Highlands Prov.:** 3 brachypterous males, 2 brachypterous females, Baiyer River, 53 km N of Mt. Hagen, 8 September 1983, CL 1783, D. A. and J. T. Polhemus (JTPC). **INDONESIA, Irian Jaya Province:** 1 female, Hollandia (Jayapura), April 1945, B. Malkin (CAS); 2 macropterous males, 1 macropterous female, 5 brachypterous males, 2 brachypterous females, 9 immatures, small rocky stream above Sentani, Cyclops Mtns., 335 m (1,100 ft), water temp. 22°C, 25 September 1991, CL 2618, D. A. and J. T. Polhemus (JTPC); 6 brachypterous males, 3 brachypterous females, rainforest stream approx. 0.5 km E of PTFI Siewa exploration camp, 3°02.14'S, 136°22.66'E, 60 m (200 ft), water temp. 26°C, 5 April 1998, 08:00–11:00 hr, CL 7089, D. A. Polhemus (USNM, LIPI); 8 brachypterous males, 3 brachypterous females, Logari River and tributaries at PTFI Landing Site 21, 3°00.35'S, 136°33.34'E, 290 m (950 ft), water temp. 24°C (main river), 7 April 1998, 09:00–14:00 hr, CL 7092, D. A. Polhemus (USNM, LIPI).

Discussion. This species was originally described from specimens taken by Biro at "Montagnes Hansmann, Baie de l'Astrolabe," a locality near current day Madang, and appears to be confined to the coastal ranges of northern New Guinea, from the Wapoga River basin eastward to at least the Huon Gulf area (Fig. 32). In general, *S. biroi* is a species of rocky foothill streams, preferring unshaded stream reaches.

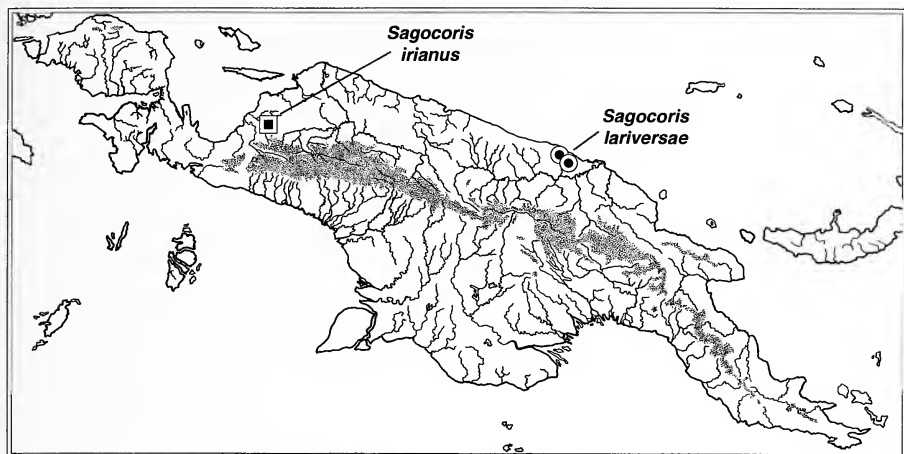


Fig. 35. Distribution of *Sagocoris* species New Guinea.

Individuals are most frequently encountered in areas of moderate flow, where the water washes over beds of moderate to small sized gravel, or along vertical stream banks.

Sagocoris gressitti La Rivers

Figs. 6–8, 22, 23, 33

Sagocoris gressitti La Rivers, 1971: 35.

Diagnosis. This species, the largest in the genus, may be recognized by its size (overall length exceeding 11.50 mm), the absence of abdominal asymmetry in females (Fig. 22), the distinctively massive female subgenital plate (Figs. 22, 23), and the structure of the male parameres and phallosoma (Figs. 6–8).

Material examined. PAPUA NEW GUINEA, **Central Prov.:** 1 brachypterous male, 1 brachypterous female, Eio Creek, nr. Baruanumu, 22 September 1983, CL 1840, J. T. and D. A. Polhemus (JTPC); 1 brachypterous male, Musgrave (Aieme) River at Awarere Plantation, 22 September 1983, CL 1841, J. T. and D. A. Polhemus (JTPC); 1 brachypterous male, Crystal Rapids, nr. Sogeri River, 25 August 1985, J. W. Ismay (JTPC). **Morobe Prov.:** 1 macropterous male, Perenin River, along Wau Road, 15 September 1983, CL 1813, J. T. and D. A. Polhemus (JTPC); 1 brachypterous female, Gurakor Creek, along Wau Road, 15 September 1983, CL 1814, J. T. and D. A. Polhemus (JTPC); 1 brachypterous male, 1 brachypterous female, Bulolo River at Wau, 900 m (2,950 ft), 16 September 1983, CL 1815, J. T. and D. A. Polhemus (JTPC); 3 brachypterous males, 5 brachypterous females, Poverty Creek, nr. Wau, 16 September 1983, CL 1816, J. T. and D. A. Polhemus (JTPC); 7 brachypterous males, Bamboo Creek, nr. Wau, 16 September 1983, CL 1817, J. T. and D. A. Polhemus (JTPC); 1 brachypterous male, Clearwater Creek, nr. Wau, 16 September 1983, CL 1818, J. T. and D. A. Polhemus (JTPC); 4 brachypterous males, 5 brachypterous females, Crystal Creek, nr. Wau, 17 September 1983, CL 1827, J. T.

and D. A. Polhemus (JTPC); 3 brachypterous females, stream 1.5 km N of Mumeng, 19 September 1983, CL 1832, J. T. and D. A. Polhemus (JTPC); 3 brachypterous males, 1 brachypterous female, Wampit River, 10.7 km S of Mumeng, 19 September 1983, CL 1833, J. T. and D. A. Polhemus (JTPC); 1 macropterous male, 9 brachypterous males, 5 brachypterous females, stream 17.8 km N of Mumeng, 19 September 1983, CL 1835, J. T. and D. A. Polhemus (JTPC); 1 brachypterous female, Lae-Bulolo Road, Gurakor Creek, Stn. 133, 30 December 1964, M. E. Bacchus (BPBM); 2 brachypterous males, 2 brachypterous females, 6 immatures, Mt. Missim, 860 m (2,820 ft), December 1969, J. H. Sedlacek (BPBM); 2 brachypterous males, 1 brachypterous female, Tuoima River, 12 December 1969, J. H. Sedlacek (BPBM); 1 brachypterous female, Bulolo River, 960 m (3,150 ft), 14 April 1966, J. L. Gressitt and G. Lippert (holotype, BPBM). **Southern Highlands Prov.:** 4 brachypterous males, 15 brachypterous females, 7 immatures, branch of upper Kara Creek (trib. to Digimu River), 5.5 km S of Moro oil camp, on road to Ridge Camp, 900 m (2,950 ft), water temp. 20°C, 12 March 1995, CL 7017, D. A. Polhemus (BPBM); 2 brachypterous males, 2 brachypterous females, 2 immatures, branch of upper Kara Creek (trib. to Digimu River), 3.5 km S of Moro oil camp, on road to Ridge Camp, 900 m (2,950 ft), water temp. 20°C, 13 March 1995, CL 7018, D. A. Polhemus (BPBM); 1 brachypterous male, 1 brachypterous female, upper Mubi River at Swinging Bridge, nr. Tubage, NE of Moro, 900 m (2,950 ft), water temp. 20°C, 14 March 1995, CL 7020, D. A. Polhemus (BPBM); 1 brachypterous male, rocky stream entering Lake Kutubu near Enu, 800 m (2,624 ft), water temp. 24°C, 15 March 1995, CL 7025, D. A. Polhemus (BPBM); 3 brachypterous females, small rocky stream on N slope of Mt. Bosavi, 1,250 m (4,100 ft), water temp. 19°C, 16 March 1995, 14:30–17:00 hr, 17 March 1995, CL 7026, D. A. Polhemus (BPBM); 1 brachypterous female, Kerisa Creek at Moro oil camp, 840 m (2,755 ft), water temp. 22°C, 21 March 1995, CL 7030, D. A. Polhemus (BPBM). **Western Highlands Prov.:** 1 brachypterous male, 2 brachypterous females, Walo River, 50 km N of Mt. Hagen, 8 September 1983, CL 1794, J. T. and D. A. Polhemus (JTPC); 1 brachypterous female, 3 immatures, 17 km N of Mt. Hagen, 6 September 1983, CL 1780, J. T. and D. A. Polhemus (JTPC); 1 macropterous male, 4 macropterous females, 2 brachypterous males, 5 brachypterous females, 4 immatures, Baiyer River, 53 km N of Mt. Hagen, 8 September 1983, CL 1783, J. T. and D. A. Polhemus (JTPC); 3 brachypterous males, 3 brachypterous females, 1 immature, stream at Baiyer River bird sanctuary, 8 September 1983, CL 1792, J. T. and D. A. Polhemus (JTPC); 3 brachypterous males, 2 brachypterous females, 1 immature, Trauna River, nr. Baiyer River, 8 September 1983, CL 1793, J. T. and D. A. Polhemus (JTPC).

Discussion. This species was originally described from specimens taken in the Bulolo River near Wau, and is widespread at intermediate elevations in the central highlands of Papua New Guinea, being known from drainages both north and south of the island's central divide (Fig. 33). In general, *S. gressitti* occurs in higher, colder waters than *S. biroi*, and is common in the vicinity of Wau, where the latter species is absent. Like *S. biroi*, it occurs in stream reaches of moderate depth, with individuals found primarily in areas with a cobble bottom swept by moderate current.

The female subgenital plate in this species shows a certain degree of variation (Figs. 22, 23), with individuals from the Sogeri Plateau, southeast of Port Moresby, having the tip of the plate more extended in comparison to those from the Wau, Mt. Hagen, and

Lake Kutubu areas. This is considered herein to be no more than localized intraspecific variation based on the meagre material (one female and three males) currently at hand from the Sogeri area, but given that the southern Papuan Peninsula is a distinct area of endemism for many species of aquatic Heteroptera, subsequent collections may show these Sogeri populations to represent a separate species.

A specimen in the Bishop Museum collection from Gurakor Creek bears a La Rivers label reading "*Sagocoris bifidus* PARATYPE," a name with no validity.

Sagocoris lariversae La Rivers

Figs. 1–5, 15–17, 19, 35

Sagocoris lariversae La Rivers, 1971: 40.

Diagnosis. This species is the smallest in the genus, and may be recognized on the basis of its size (overall length less than 9.0 mm), the angulate projections of the posterolateral angles of the pronotum in brachypterous forms (Fig. 2), the shape of the female subgenital plate (Fig. 19), and the structure of the male parameres and phallosoma (Figs. 15–17).

Material examined. PAPUA NEW GUINEA, **East Sepik Prov.:** 18 macropterous males, 11 macropterous females, 7 brachypterous males, 11 brachypterous females, 10 immatures, Nagam River, 3 km S of Pasam, 10 September 1983, CL 1799, J. T. and D. A. Polhemus (JTPC); 1 macropterous male, 1 macropterous female, 3 brachypterous males, 2 brachypterous females, Yemogu Creek, 2 km W of Tring, 12 September 1983, CL 1805, J. T. and D. A. Polhemus (JTPC); 4 macropterous females, 4 brachypterous males, 1 brachypterous female, waterfall and limestone stream nr. Pasam, S of Wewak, 10 September 1983, CL 1798, J. T. and D. A. Polhemus (JTPC); 10 males, 5 females (paratypes), Nagam River, 17 mi SE of Wewak, July 6, 1969, I. La Rivers (paratypes, CAS).

Discussion. This species was originally described from specimens taken in the Nagam River, south of Wewak, and appears on the basis of current records to be confined to the Prince Alexander Range of northern Papua New Guinea (Fig. 35), although it is likely to occur in the adjacent Torricelli Mountains as well. At the Nagam River type locality, *S. lariversae* was found under stones in shallow, silty riffles with moderate to slow current. *Aptinocoris sedlaceki* was also present at this locality, but occurred instead in faster riffles with gravel substrates.

Sagocoris asymmetricus (La Rivers) **new combination**

Figs. 20, 34

Quadricoris asymmetrica La Rivers, 1971: 51.

Diagnosis. This unusual species may be easily recognized by the massively prolonged and asymmetrical left paratergite V in females (Fig. 20), and by the structure of the female subgenital plate, which is deeply concave at the tip (Fig. 20). The male is unknown.

Material examined. PAPUA NEW GUINEA, **Northern Prov.:** 2 females, Kokoda, 365 m (1,200 ft), May 1933, L. E. Cheesman, B. M. 1933-577 (holotype and paratype, BMNH).

Discussion. Although considered a member of a separate monotypic genus by La

Rivers (1971), this taxon is simply a *Sagocoris* with a highly modified female abdominal morphology. The most unusual aspect of this species is the asymmetrical prolongation of the abdomen begins with segment V, rather than with segment VI, as is the case in all other known *Sagocoris* species. Only two females are known, so the male genital morphology cannot be compared to that of other congeners.

Based on the current collections, this species appears to be confined to the northern section of the Papuan Peninsula (Fig. 34); nothing is known regarding its habitat preferences.

***Sagocoris intermedius* new species**

Figs. 12–14, 21, 34

Diagnosis. This species may be recognized by the weakly expressed asymmetry of the female abdomen (Fig. 21), the shape of the female subgenital plate (Fig. 21), and the structure of the male parameres and phallosoma (Figs. 12–14).

Description. *Brachypterous form.* Moderately large for genus, form ovate, basic coloration dull yellowish brown with scattered dark brown or black markings. Male length 11.70, maximum width (across abdomen) 6.20; female length 11.50, maximum width 6.20. *Head* dark yellowish brown, with paired longitudinal stripes medially to either side of midline, width/length = 3.60/2.00; eyes black, shining, width/length = 0.70/1.50, inner margins weakly convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 2.00/2.25, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance much less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 6.25/2.20, lateral margins narrowly glabrous, broadly rounded, posterolateral angles acutely rounded, posterior margin bisinuate. *Scutellum* dark brown, width/length (midline) = 3.40/1.85, lateral margins very weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* dark brown, lighter brown narrowly bordering scutellum, along claval commissure, and on basal $\frac{3}{4}$ of embolium, each hemelytron also with two small dark yellow spots, one near inner posterior margin of embolium, another at posteromedial apex of corium, surface of corium coarsely rugose, membrane reduced, venation obscure, tips of hemelytra acutely rounded, extending to base of genital segment, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae. *Abdomen* with lateral portions of segments III–VIII plus extreme posterolateral angle of tergite II exposed when viewed dorsally, all visible tergites uniformly dark yellowish, posterolateral angles of all tergites bearing slender tufts of elongate gold setae, posterolateral angles of segments II–V moderately produced and spinose, angles of segment VI and VII acute, weakly asymmetrical, more highly produced on left side (Fig. 21), angles of segment VIII acute.

Ventral surface light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially. *Legs* dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing single glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, roughly ovate (Fig. 12); right paramere larger, curving (Fig. 14); male phallosoma with tip expanded, quadrate (Fig. 13). *Female subgenital plate* roughly trapezoidal, weakly asymmetrical, tip broadly and shallowly concave (Fig. 21).

Macropterous form. Unknown.

Types. Holotype, brachypterous male, INDONESIA, **Irian Jaya Prov.**, Hambolan River, Elelim, 200 km NW of Wamena, 650 m (2,130 ft), 19 January 1992, R. Ubaidillah (LIPI). Paratypes: INDONESIA, **Irian Jaya Prov.**: 2 brachypterous males, 2 brachypterous females, 6 immatures, same data as holotype (USNM, JTPC). **Etymology.** The name "intermedius" refers to the size of this species in relation to others in the genus.

Discussion. *Sagocoris intermedius*, as its name implies, is intermediate in size between *S. gressitti* and *S. biroi*, and shows only an incipient trend toward the abdominal asymmetry that is so pronounced in the latter species. This is the only species of *Sagocoris* so far known from the northern slopes of the Irian Jaya central ranges draining to the Mamberamo River basin (Fig. 34). No information is available regarding its habitat preferences.

***Sagocoris irianus* new species**

Figs. 24–27, 35

Diagnosis. This species may be recognized by the moderately expressed asymmetry of paratergite VI in females (Fig. 24), the shape of the female subgenital plate, which is roughly trapezoidal and lacks a broad concavity at the tip (Fig. 24), and by the structure of the male parameres and phallosoma (Figs. 25–27).

Description. *Brachypterous form.* Moderate sized for genus, form ovate, basic coloration dull yellowish brown with scattered dark brown or black markings. Male length 10.80, maximum width (across abdomen) 6.70; female length 10.90, maximum width 7.00. *Head* dark yellowish brown, with paired longitudinal markings medially to either side of midline, width/length = 3.40/1.80; eyes black, shining,

width/length = 0.60/1.20, inner margins weakly convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 2.00/2.15, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance much less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 5.80/1.80, lateral margins narrowly glabrous, broadly rounded, posterolateral angles forming very small spinose projections, posterior margin bisinuate. *Scutellum* dark brown, width/length (midline) = 3.00/1.70, lateral margins very weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* dark brown, lighter brown narrowly bordering scutellum, along claval commissure, and on basal $\frac{3}{4}$ of embolium, each hemelytron also with two small dark yellow spots, one near inner posterior margin of embolium, another at posteromedial apex of corium, surface of corium coarsely rugose, membrane reduced, venation obscure, tips of hemelytra acutely rounded, not attaining base of genital segment, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae. *Abdomen* with lateral portions of segments III–VIII plus extreme posterolateral angle of tergite II exposed when viewed dorsally; all visible tergites uniformly dark yellowish, posterolateral angles of all tergites bearing slender tufts of elongate gold setae; posterolateral angles of segments III–VII in male moderately produced and spinose, angles of male segment VIII rounded; abdominal segment VI in female moderately asymmetrical, more highly produced on left side (Fig. 24), angles of segments III–V and VII moderately produced and acute. *Ventral surface* light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially. *Legs* dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing single glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, roughly ovate, with a slight inflection at the tip (Fig. 25); right paramere larger, curving (Fig. 26); male phallosoma

with tip rounded and bearing a membranous lobe (Fig. 27). *Female subgenital plate* roughly trapezoidal, symmetrical, tip truncate, weakly concave medially (Fig. 24).

Macropterous form. Unknown.

Types. Holotype, brachypterous male, INDONESIA, **Irian Jaya Prov.**, cobble bottomed overflow channel adjoining Tirawiwa River, 0.5 km W of PTFI Siewa exploration camp, 3°02.66'S, 136°22.34'E, 60 m (200 ft), water temp. 28°C, 3 April 1998, 12:00–15:15 hr, CL 7086, D. A. Polhemus (LIPI). Paratypes: INDONESIA, **Irian Jaya Prov.**: 18 brachypterous males, 12 brachypterous females, same data as holotype (USNM, LIPI).

Etymology. The name “irianus” refers to the western portion of New Guinea, known as Irian to Malay speaking peoples.

Discussion. *Sagocoris irianus* is superficially similar to *S. biroi* in general size and coloration, but shows far less development of abdominal asymmetry, and has a much differently shaped female subgenital plate (compare Figs. 18, 24).

This species is currently known only from the Wapoga River basin of northern Irian Jaya, an area where the central and northern coastal ranges of the island converge (Fig. 35). Given this, it is uncertain as to whether the broader range of this species will eventually prove to encompass the northern coastal ranges, the north flank of the central ranges, or both. As noted previously, another congeneric species, *S. intermedius*, occurs on the northern flanks of the central ranges in the area to the east of that occupied by *S. irianus*, and it may be that the two species are each confined to separate drainage basins, with *S. irianus* in the Wapoga and *S. intermedius* in the Mamberamo. Clarification of these distributions must await further collections from northern Irian Jaya.

The type series of *S. irianus* was taken along the margin of a clear, slowly flowing, cobble-bottomed overflow channel adjacent to the main Tirawiwa River. The insects aggregated along the edges of this channel amid tangles of submerged sticks and grasses, in areas partially shaded by the riparian rain forest.

***Sagocoris flavinotum* new species**

Figs. 28–31, 34

Diagnosis. This species may be recognized by the near-absence of female abdominal asymmetry (Fig. 28), the shape of the female subgenital plate, which is roughly trapezoidal and has a broadly concave tip (Fig. 28), by the structure of the male parameres and phallosoma (Figs. 29–31), and by the yellowish brown pronotum with very limited black markings.

Description. *Brachypterous form.* Moderate sized for genus, form ovate, basic coloration dull yellowish brown, scutellum and hemelytra dark brown. Male length 10.50, maximum width (across abdomen) 6.60; female length 10.40, maximum width 6.50. *Head* dark yellowish brown, with small paired longitudinal brown markings medially to either side of midline, width/length = 3.50/2.00; eyes black, shining, width/length = 0.60/1.45, inner margins weakly convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 1.95/2.25, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance much less

than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* dark yellowish, with a pair (1+1) of short black longitudinal streaks behind eyes to either side of midline; not depressed medially behind vertex, width/length (midline) = 5.90/2.00, lateral margins narrowly glabrous, broadly rounded, posterolateral angles rounded, lacking small spinose projections, posterior margin weakly bisinuate. *Scutellum* dark brown, width/length (midline) = 2.00/1.40, lateral margins very weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* dark brown, lighter brown on basal $\frac{1}{2}$ of embolium, additional dark yellow spots faintly suggested at posteromedial apex of corium on each hemelytron; surface of corium coarsely rugose, membrane reduced, venation obscure, tips of hemelytra acutely rounded, not attaining base of genital segment, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing sparse fringe of long recumbent gold setae. *Abdomen* with lateral portions of segments III–VIII plus extreme posterolateral angle of tergite II exposed when viewed dorsally; all visible tergites dark yellowish except central portion of tergite V medium brown in male; posterolateral angles of all tergites bearing slender tufts of elongate gold setae; posterolateral angles of segments III–VII in male moderately produced and spinose, angles of male segment VIII rounded; abdomen in female very weakly asymmetrical on distal segments (Fig. 28), posterolateral angle of abdominal segment VI slightly more truncate and less acute on left side, posterolateral angle of segment VII slightly more slender and acute, angles of segments III–V symmetrical, moderately produced and acute. *Ventral surface* yellowish brown on head and thorax, light medium brown on abdomen; head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially. *Legs* dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing single glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of tiny dark spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, roughly ovate, slightly produced at tip (Fig. 29); right paramere larger, curving (Fig. 30); male phallosoma with tip broadly rounded (Fig. 31). *Female subgenital plate* roughly trapezoidal, symmetrical, posterior margin broadly concave (Fig. 28).

Macropterous form. Unknown.

Etymology. The name "flavinotum" refers to the distinctive yellowish pronotum of this species.

Discussion. *Sagocoris flavinotum* is similar in some respects to *S. intermedius* from the northern face of the Irian Jaya central highlands, but may be easily separated by the differently formed female abdominal segments and male genitalia (compare Figs. 12–14, 21 and 28–31). This species shows only the most incipient development of the female abdominal asymmetry that becomes progressively more pronounced in *S. intermedius*, *S. irianus*, *S. biroi* and *S. asymmetricus*. Taken in combination with *S. gressitti*, which displays no female abdominal asymmetry, the six known species of *Sagocoris* thus display a well defined morphocline in relation to the development of this character. If we exclude *S. gressitti*, which occurs at higher elevations than the other species and is the only species found both north and south of the central drainage divide, then the development of this abdominal asymmetry in *Sagocoris* becomes steadily more pronounced as one moves from west to east along the northern coast of New Guinea.

The few specimens of *S. flavinotum* so far taken have all come from the margins of rocky upland streams; the series from the Logari River tributary type locality was taken by scooping in the standing water beneath a fallen log in a sheltered side pool shallowly connected to the main stream channel.

Types. Holotype, brachypterous male, INDONESIA, **Irian Jaya Prov.**, rocky tributary to Logari River, approx. 0.5 km W of PTFI Landing Site 21, 3°00.45'S, 136°33.23'E, 295 m (970 ft), water temp. 25°C, 6 April 1998, 12:30–14:30 hr, CL 7091, D. A. Polhemus (LIPI). Paratypes: INDONESIA, **Irian Jaya Prov.**: 1 brachypterous male, 1 brachypterous female, same data as holotype (USNM); 1 brachypterous male, Logari River at PTFI Landing Site 21, 3°00.35'S, 136°33.34'E, 290 m (950 ft), water temp. 24°C, 7 April 1998, 09:00–14:00 hr, CL 7092, D. A. Polhemus (LIPI).

Aptinocoris Montandon, 1897

Figs. 36–74

Description. Moderate sized, ovate naucorids (Fig. 36), length 5.40–10.10; basic coloration dull yellowish brown with scattered dark brown or black markings on head, thorax, and dorsal abdomen; hemelytra and scutellum often predominantly brown. Brachypterous forms predominating. *Head* usually dark yellowish brown, with paired longitudinal stripes medially to either side of midline; eyes with dorsal surfaces not rising above plane of vertex, inner margins slightly convergent anteriorly, separated from vertex by shallow furrows, lateral flanges small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally; maxillary plates moderately developed, inner margins adjoining rostral cavity oriented vertically, anterior margins glabrous, carinate, forming sides of rostral cavity; rostrum extending beyond labrum; antennae slender, segments III and IV filiform (Fig. 38), not extending beyond eye margins. *Pronotum* usually dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, lateral mar-

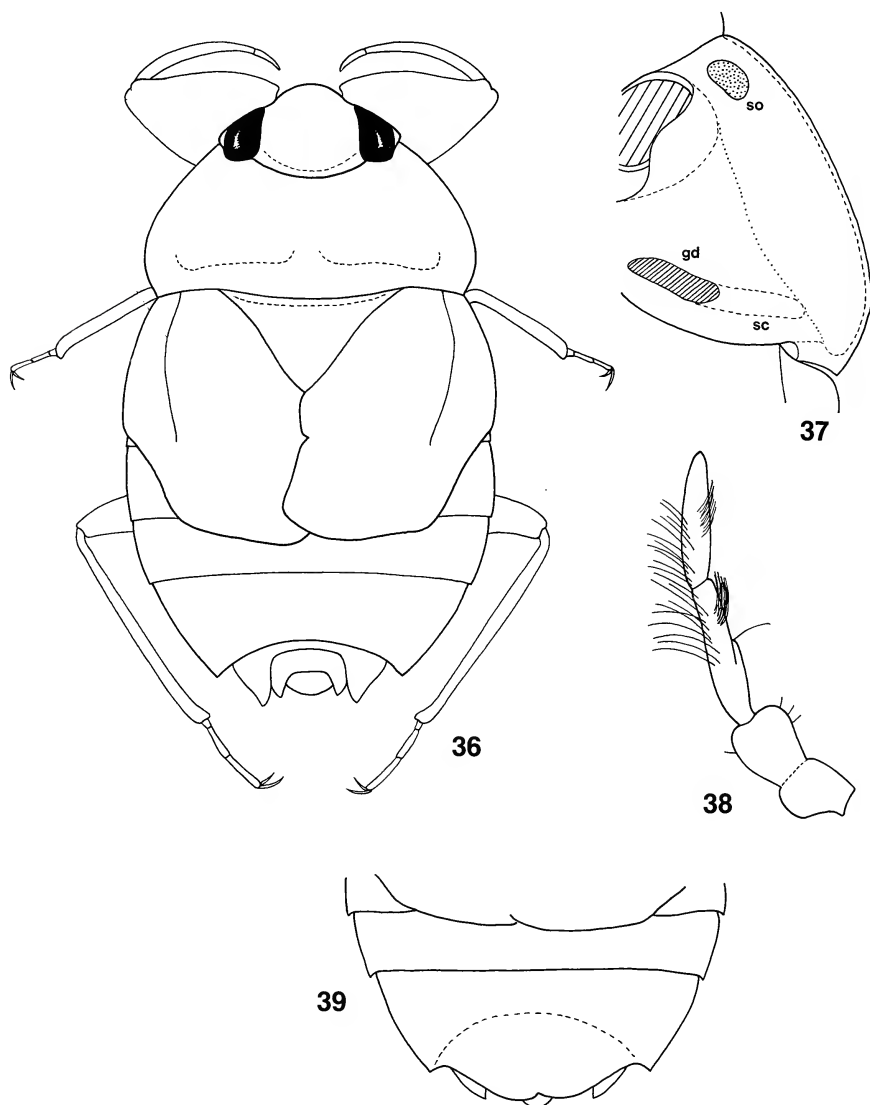
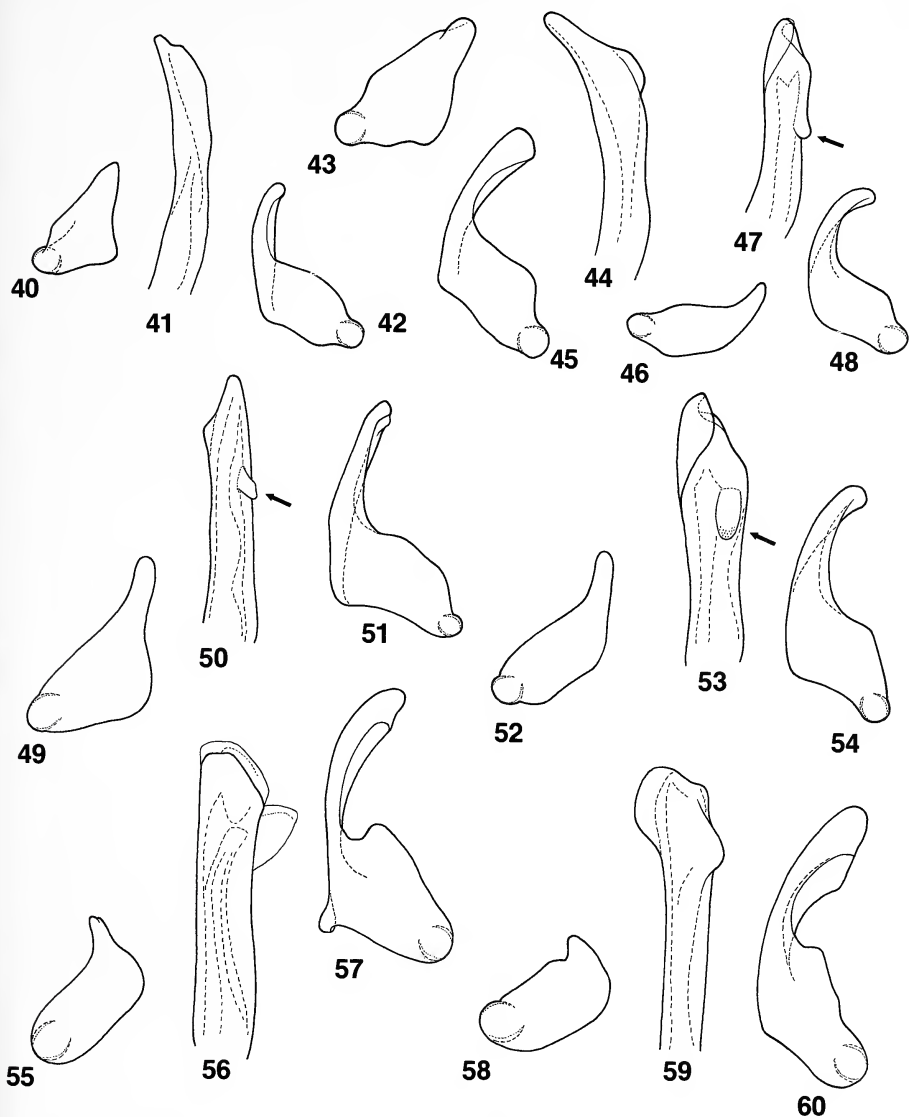


Fig. 36. *Aptinocoris sogeri*, brachypterous female, dorsal habitus.

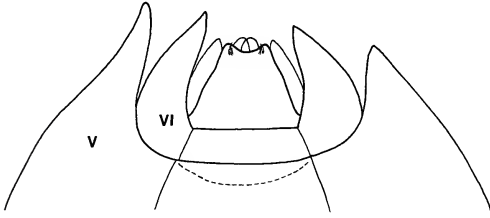
Fig. 37. *Aptinocoris sedlaceki*. Ventral view of propleuron, showing locations of hydrostatic sense organ (so), glabrous depression (gd), and associated elongate sulcus hypothesized to be a secretory channel (sc).

Fig. 38. *Aptinocoris boikiki*, structural details. Male right antenna, ventral view; note slender form of segments III and IV in relation to enlarged basal segments I and II.

Fig. 39. Terminal male abdominal tergites, dorsal view, showing location of medial notch on tergite V; this notch cradles the phallosoma when the latter structure is everted from the genital capsule.



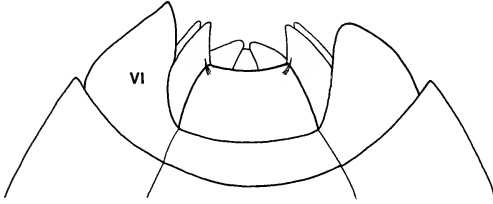
Figs. 40–60. Male genitalia of *Aptinocoris* species; all structures in dorsal view, as seen when at rest in genital capsule. Arrows indicate locations of lightly sclerotized preapical lobes on the phallosoma of certain species. Figs. 40–42, *A. fenneri*. 40. Left paramere. 41. Phallosoma. 42. Right paramere. Figs. 43–45, *A. boikiki*. 43. Left paramere. 44. Phallosoma. 45. Right paramere. Figs. 46–48, *A. minutus*. 46. Left paramere. 47. Phallosoma. 48. Right paramere. Figs. 49–51, *A. sogeri*. 49. Left paramere. 50. Phallosoma. 51. Right paramere. Figs. 52–54, *A. papuus*. 52. Left paramere. 53. Phallosoma. 54. Right paramere. Figs. 55–57, *A. cheesmanae*. 55. Left paramere. 56. Phallosoma. 57. Right paramere. Figs. 58–60, *A. sedlaceki*. 58. Left paramere. 59. Phallosoma. 60. Right paramere.



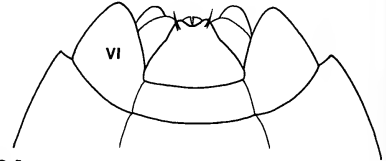
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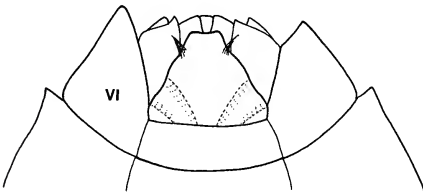
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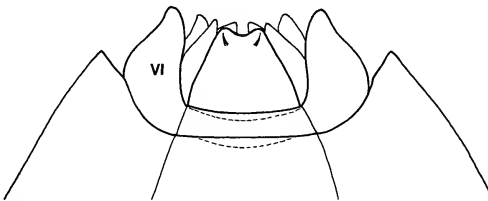
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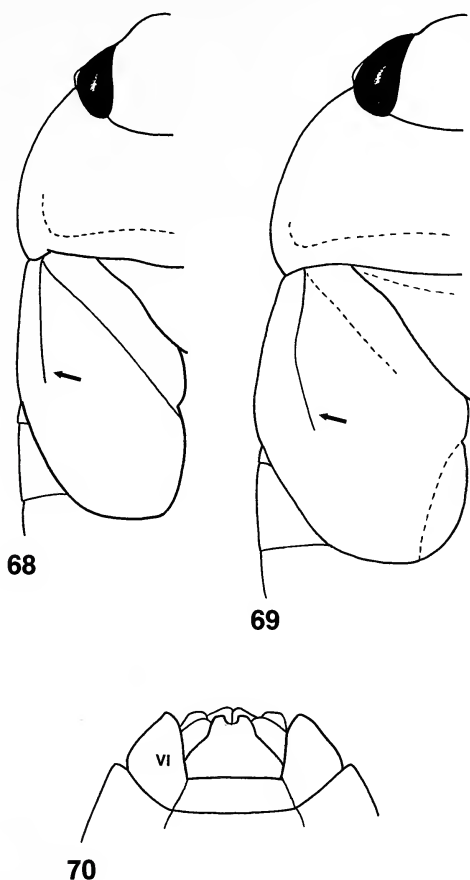


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67

Figs. 61–67. Ventral views of terminal female abdominal structures in *Aptinocoris* species, with the relative positions of paratergites V and/or VI indicated. 61. *A. boikiki*. 62. *A. minutus*. 63. *A. cheesmanae*. 64. *A. papuus*. 65. *A. sedlaceki*. 66. *A. fenneri*. 67. *A. sogeri*.



Figs. 68, 69. *Aptinocoris* species, details of pronotum and left hemelytron in brachypterous forms. Arrows indicate posterior terminus of embolar furrow. 68. *A. ziwa*. 69. *A. papuus*.

Fig. 70. *Aptinocoris ziwa*, terminal female abdominal structures, ventral view, with the relative position of paratergite VI indicated.

gins narrowly glabrous, broadly arcuate, posterolateral angles acute, posterior margin bisinuate. Scutellum generally dark brown, lateral margins sinuate, transverse sulcus present along anterior margin. Hemelytra predominantly dark brown, surface of corium coarsely rugose; membrane extremely reduced, obscure; hemelytra posteriorly truncate in brachypterous forms, extending to middle of abdominal tergite IV; embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae; hemelytral commissure with small triangular tab on left hemelytron fitting into corresponding triangular indentation on right hemelytron. *Abdomen* with lateral portions of tergites II and III, lateral and posterior portions of tergite IV, and entirety of tergites V–VII exposed in both sexes when viewed dorsally; male with lateral

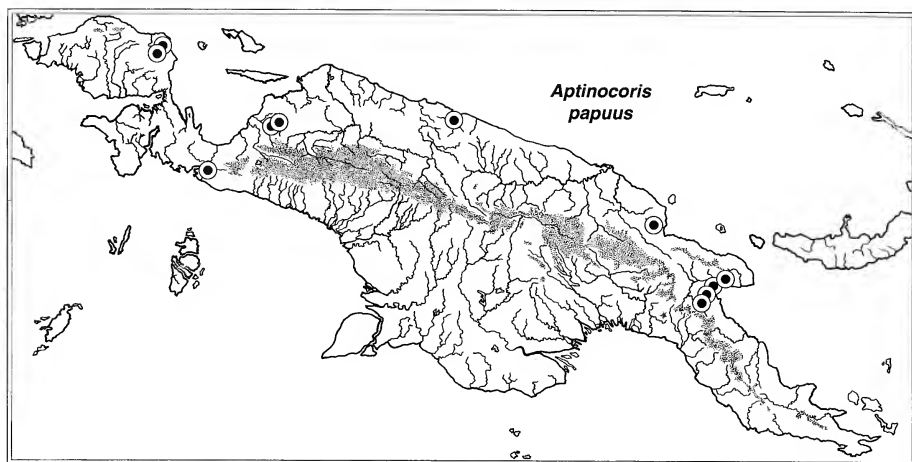


Fig. 71. Distribution of *Aptinocoris papuus* in New Guinea.

portions of tergite VIII also visible from above; tergite V in males usually weakly asymmetrical, with a posteromedial indentation slightly offset to right of center as viewed from above (Fig. 39); angles of segments V and VI in females often asymmetrical to varying degrees, sometimes strongly so, with posterolateral angles more highly produced on left side (Figs. 61–67). *Ventral surface* of head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; head with glabrous median longitudinal keel, this becoming more pronounced posteriorly, meeting similar and continuous but more pronounced structure on prosternum; proepimeron densely covered with very short fine recumbent gold setae, inner proepimeral projections not touching medially, posterior section of proepimeron with deep glabrous depression, flanked laterally by elongate sulcus leading laterally toward posterolateral angle (Fig. 37), hydrostatic sense organs present as ovate depressed patches at anterolateral angles (Fig. 37); mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially; abdominal paratergites III–VI with paired elongate glabrous openings in the hydrofuge pile adjacent to spiracle, spiracle represented by small raised protruberance thickly covered with gold hydrofuge setae, paratergites II and VII each with single glabrous openings, all paratergites with lateral margins narrowly glabrous. *Legs* generally dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face, anterior tarsi single segmented, claw tiny, obscure, single, fused to tarsus; middle and hind coxae bearing large glabrous tubercles distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines

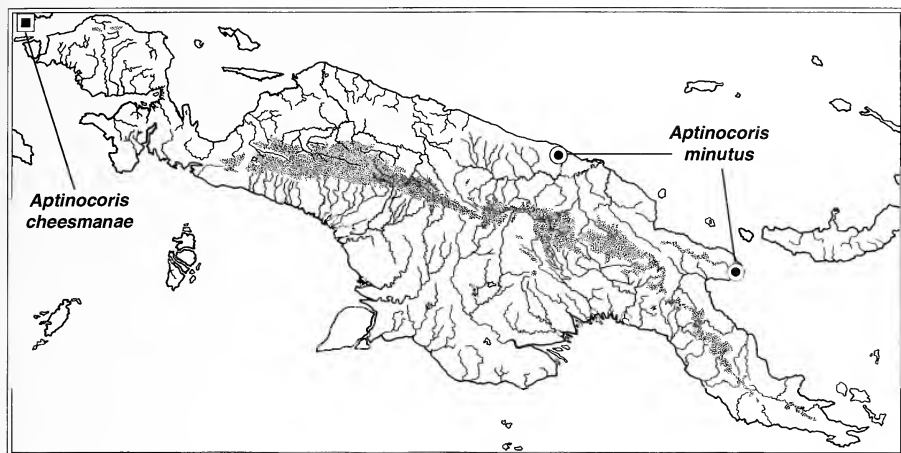


Fig. 72. Distribution of *Aptinocoris* species in New Guinea.

longer and more dense distally, middle and hind tibiae also with several transverse rows of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent, parempodia setiform. *Male genitalia* with parameres asymmetrical; left paramere greatly reduced (Figs. 40, 43, 46, 49, 52, 55, 58), right paramere larger, with an elongate, curving distal arm (Figs. 42, 45, 48, 51, 54, 57, 60); male phallosoma asymmetrical, tip often expanded and bearing lightly sclerotized preapical lobes (Figs. 41, 44, 47, 50, 53, 56, 59). *Female subgenital plate* roughly trapezoidal, symmetrical, tip often broadly and shallowly concave (Figs. 61–67, 70).

Macropterous forms. Similar to brachypterous forms in general structure and coloration, with following exceptions: pronotum slightly expanded, with posterolateral angles less acute; scutellum weakly raised; hemelytra with claval and embolar sutures well defined; membrane fully developed, reaching to base of genital segment, lacking evident venation.

Discussion. The shape of the right paramere in *Aptinocoris* is relatively conservative, but shows two basic trends. In *A. cheesmanae* and *A. sedlaceki*, the tip of the paramere is slightly expanded (Figs. 57, 60), and resembles the shape seen in *Sagocoris*. In the remaining species the tip of the paramere is more slender (Figs. 42, 45, 48, 51, 54) and begins to approach the condition seen in *Idiocarus*. The shape of the left paramere is by contrast quite variable, and more diagnostic of individual species, but in all cases this structure is reduced in comparison to the right paramere (Figs. 40, 43, 46, 49, 52, 55, 58). The phallosoma is asymmetrical, and often has lightly sclerotized preapical lobes at or near the tip (Figs. 41, 44, 47, 50, 53, 56, 59). The renderings provided should be taken as approximate, since these lobes are somewhat delicate and can be damaged during dissection. The sclerotized portion of the phallosoma is less extensive than in *Sagocoris* and usually forms an acute angle at the tip.

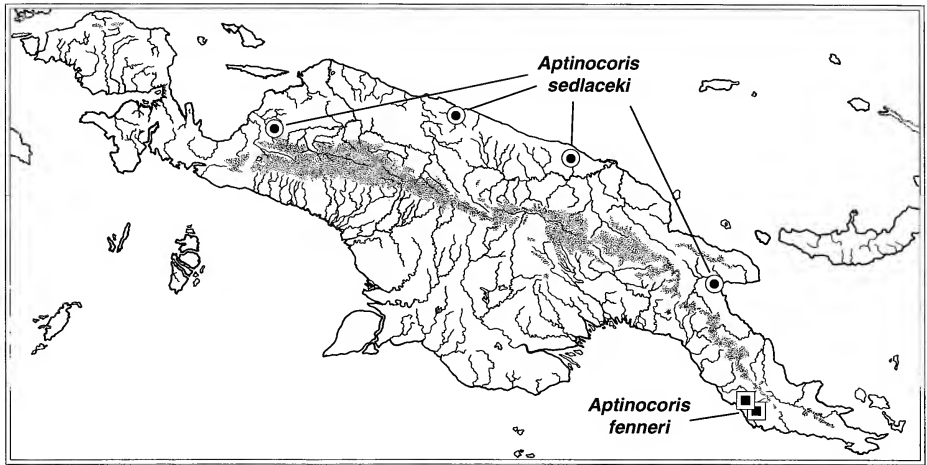


Fig. 73. Distribution of *Aptinocoris* species in New Guinea.

In general, *Aptinocoris* species occur in faster waters than *Sagocoris* species, and this coupled with their abbreviated hemelytra and incipient hydrostatic sense organ on the proepimeron suggests that they may employ a plastron for respiration.

Aptinocoris papuus Montandon

Figs. 52–54, 64, 71

Aptinocoris papuus Montandon, 1897: 64.

Sagocoris browni, La Rivers, 1971:42 **new synonymy**

Diagnosis. This species may be distinguished by its relatively small size (overall length less than 8.0 mm), the absence of abdominal asymmetry in the females of most populations (Fig. 64), and by the structure of the male genitalia (Figs. 52–54), with the left paramere bearing an elongate tip that causes it to appear more similar in size to the right paramere, rather than being clearly reduced and truncate as in most other members of the genus.

Supplemental redescription of holotype. General coloration yellowish brown, with scutellum, hemelytra excluding embolium, lateral margins of all exposed abdominal tergites, and muscle scars on head and pronotum darker brown; eyes black. Body length 7.14, maximum width (across base of abdomen) 3.85; head length 1.40, width 1.89, anterior/posterior interocular 1.05/1.26, eye length 0.77, width 0.35; pronotum length (midline) 1.12, width 3.36; scutellum length 1.12, width 2.10. Hemelytra brachypterous, truncate, posterior margins squared off and perpendicular to the long axis of the body.

Material examined. INDONESIA, **Irian Jaya Prov.:** 1 brachypterous female, Hatam [Arfak Mtns., Vogelkop Peninsula], VI-1875, Beccari (holotype, MSNG); 13 brachypterous males, 10 brachypterous females, 5 immatures, small rocky stream at Aimasi Hulu, Arfak Mtns., 65 km SW of Manokwari, 140 m (450 ft), water temp.

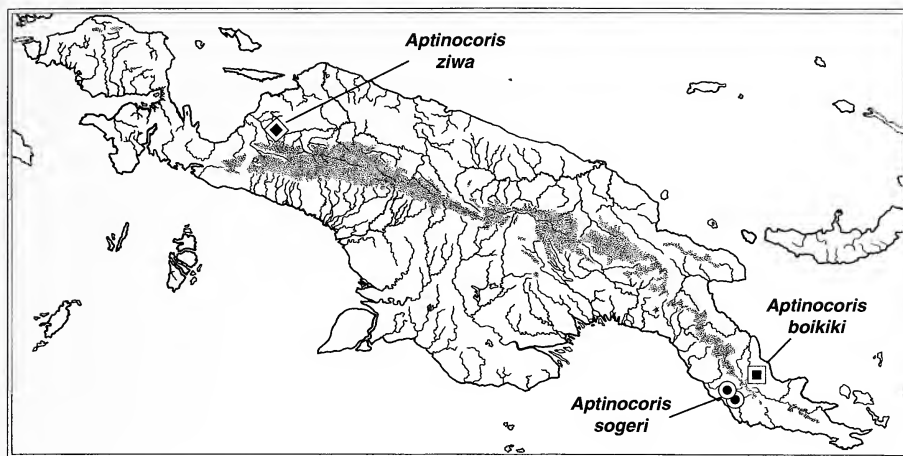


Fig. 74. Distribution of *Aptinocoris* species in New Guinea.

25°C, 19 October 1991, CL 2649, D. A. and J. T. Polhemus (JTPC, BPBM, LIPI); 5 brachypterous males, 6 brachypterous females, 1 immature, Prafi River, Arfak Mtns., 48 km SE of Manokwari, 215 m (700 ft), water temp. 26.5°C, 19 October 1991, CL 2652, D. A. and J. T. Polhemus (JTPC, BPBM, LIPI); 4 macropterous males, 4 macropterous females, 5 brachypterous males, 5 brachypterous females, 4 immatures, Subsai River, Arfak Mtns., 45 km SE of Manokwari, 120 m (400 ft), water temp. 29°C, 19 October 1991, CL 2653, D. A. and J. T. Polhemus (JTPC, BPBM, LIPI); 1 brachypterous male, Gen. Major Quantkamp, N of Lake Sentani, Ifar, 450 m (1,475 ft), 30 November 1955, L. D. Brongersma (RNHL); 1 brachypterous female, Hollandia [Jayapura], April 1945, B. Malkin (CAS); 2 brachypterous males, 2 brachypterous females, small rocky stream along N side of PTFI Etna Bay exploration camp, head of Etna Bay, 0–60 m (0–200 ft), 3°58.10'S, 134°57.68'E, water temp. 25–27°C, 28–29 March 1997, CL 7077, D. A. and J. T. Polhemus (USNM); 1 macropterous male, cobble bottomed overflow channel adjoining Tira-wiwa River, 0.5 km W of PTFI Siewa exploration camp, 3°02.66'S, 136°22.34'E, 60 m (200 ft), water temp. 28°C, 3 April 1998, 12:00–15:15 hr, CL 7086, D. A. Polhemus (USNM); 1 brachypterous male, 2 brachypterous females, rainforest stream approx. 0.5 km E of PTFI Siewa exploration camp, 3°02.14'S, 136°22.66'E, 60 m (200 ft), water temp. 26°C, 5 April 1998, 08:00–11:00 hr, CL 7089, D. A. Polhemus (USNM, LIPI); 1 brachypterous female, Logari River and tributaries at PTFI Landing Site 21, 3°00.35'S, 136°33.34'E, 290 m (950 ft), water temp. 24°C (main river), 7 April 1998, 09:00–14:00 hr, CL 7092, D. A. Polhemus (LIPI). **PAPUA NEW GUIN- EA, Madang Prov.:** 2 brachypterous males, 3 brachypterous females, Gum River nr. Ohu, 11 km W of Madang, 80 m (260 ft), 27 March 1994, water temp. 28°C, 10:00–14:00 hr, CL 7035, D. A. Polhemus (BPBM). **Morobe Prov.:** 1 macropterous male, Lae, Bubia, 23 November 1956, E. S. Brown (holotype of *Sagocoris browni* La Rivers, BMNH); 10 brachypterous males, 13 brachypterous females, Oomsis, 35 km SW of Lae, 14 September 1983, CL 1810, J. T. and D. A. Polhemus (JTPC); 1

brachypterous female, Perenin River along Wau road, 15 September 1983, CL 1813, J. T. and D. A. Polhemus (JTPC); 4 brachypterous males, 5 brachypterous females, 1 immature, creek 18 km NW of Lae, 20 September 1983, CL 1837, J. T. and D. A. Polhemus (JTPC); 2 females, Lae, Bubia, 23 September 1956, E. S. Brown (CAS); 1 brachypterous female, Lae, 26 November 1961, J. Sedlacek (paratype, BPBM).

Discussion. This species was described by Montandon (1897) from a single specimen of unspecified sex collected by Odoardo Beccari in 1875 in the vicinity of Hatam, a village in the Arfak Mountains of the Vogelkop Peninsula.

La Rivers, while preparing his 1971 monograph of New Guinea naucorids, did not examine Montandon's holotype, basing his redescription instead on a single Montandon determined specimen, now housed in the California Academy of Sciences, San Francisco. We have examined this specimen, which bears the labels "D. N. Guinea, Sattelberg" and "Aptinocoris papuus Montandon, var., Id. Montandon 1913," the latter label handwritten in Montandon's own script. La Rivers interpreted the locality label to refer to Dutch New Guinea, whereas in fact it stands for Deutsch New Guinea. Sattelberg was a former German settlement lying at 900 m elevation near the tip of the Huon Peninsula north of present day Lae, and a site for many early montane biological collections in New Guinea.

After a diligent search, the actual holotype of *A. papuus* was located in the Museo di Storia Naturale "Giacomo Doria" in Genoa, Italy. It is a brachypterous female in excellent condition and glued to a card; a supplemental redescription of this specimen is provided above. The specimen bears the labels "N. Guinea, Hatam, VI-1875, Beccari," a red printed "Typus" label, and a label in Montandon's handwriting reading "Aptinocoris papuus, Mont., typus!" This specimen is not conspecific with the Sattelberg specimen determined as *A. papuus* by La Rivers (1971); the latter specimen in fact represents a new species, *Aptinocoris minutus*, which is described subsequently.

La Rivers (1971) described *Sagocoris browni* from a female taken at "Lae, Bubia," a locality in northeastern Papua New Guinea, by E. S. Brown. This species actually constitutes a member of the genus *Aptinocoris* as defined herein, and is nearly identical to *A. papuus*. The overall size, shapes of the male parameres and phallosoma, and shape of the female subgenital plate are the same between the two species, the only substantive difference between the taxa being the slight prolongation of the left posterolateral angle of abdominal tergite V in females of *S. browni* in comparison to those of *A. papuus*, where such prolongation is absent. An analysis of populations from throughout New Guinea demonstrates that this abdominal asymmetry is intraspecifically variable within *A. papuus*, with populations from Etna Bay and the Wapoga River basin having no asymmetry, populations from the Arfak Mountains of the Vogelkop Peninsula showing incipient asymmetrical development, and certain populations from northeastern Papua New Guinea having the asymmetry moderate to well developed. Given this variability, and the congruence of all other taxonomically important features among these populations, *S. browni* is herein considered a synonym of *A. papuus*.

Small specimens of *A. papuus* may also be potentially confused with *A. ziwa* n. sp., from northern central Irian Jaya, but brachypterous females of the two species (the only form so far known for *A. ziwa*) are easily separated by the shape of the

embolar furrow on the hemelytron, which runs roughly parallel to the hemelytral margin in *A. ziwa*, but curves broadly inward posteriorly in *A. papuus* (compare Figs. 68, 69).

Aptinocoris papuus is widely distributed in northern New Guinea, from the Huon Peninsula and Hertzog Mountains of Papua New Guinea west to the Vogelkop Peninsula of Irian Jaya (Fig. 71). The specimens from the Vogelkop area are somewhat larger than those from the Cyclops Mountains and Papua New Guinea, but exhibit no other substantive differences. This species is typically found in small, clear streams, where individuals occur amid rocks and cobbles in midstream, often in areas of high current velocity.

The male from Ifar in the Leiden collection and the two female specimens from Bubia in the California Academy of Sciences bear La Rivers labels reading "*Sagocoris distolus* PARATYPE," a name with no validity.

***Aptinocoris minutus* new species**

Figs. 46–48, 62, 72

Diagnosis. *Aptinocoris minutus* is the smallest naucorid known from New Guinea, and may be recognized by its reduced size (overall length less than 7.0 mm), the lack of abdominal asymmetry in the female (Fig. 62), the structure of the male genitalia (Figs. 46–48), and the predominantly light brown coloration, particularly the yellowish pronotum that contrasts sharply with the brown hemelytra.

Description. *Brachypterous* form. Small for genus, form ovate, basic coloration pale yellowish brown with limited brown markings on pronotum, hemelytra uniformly pale brown. Male length 5.40, maximum width (across abdomen) 3.10; female length 6.15, maximum width 3.20. *Head* pale yellowish brown, becoming darker brown along posterior margin, with faint paired longitudinal brown stripes medially to either side of midline, width/length = 1.55/0.80; eyes black, shining, width/length = 0.37/0.50, inner margins convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 0.85/1.00, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* pale yellowish brown, bearing limited brown markings to either side of midline at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 2.90/0.90, lateral margins arcuate, posterolateral angles acute, posterior margin bisinuate. *Scutellum* pale yellowish brown, lateral margins narrowly darker, width/length (midline) = 1.75/0.75, lateral margins very weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* pale brown, yellowish on basal $\frac{1}{5}$ of embolium; surface of corium coarsely rugose, membrane reduced, obscure, hemelytra truncate posteriorly, extending only to middle of abdominal tergite IV, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae. *Abdomen* with all visible

tergites uniformly yellowish brown; posterolateral angles of all tergites bearing slender tufts of elongate gold setae; posterolateral angles of segments II–V in both males and females not produced or spinose; posterolateral angles of segments VI–VIII in male angulate, symmetrical, posteromedial portion of male tergite V symmetrical, lacking a small central notch; segments VI–VII of female symmetrical, angulate (Fig. 62). *Ventral surface* light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, forming a rounded tumescence anteromedially, this tumescence separated by transverse sulcus from broader tumescence posteromedially. *Legs* pale yellowish brown, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing a single large glabrous tubercle distally, lacking rows of short reddish spines ventrally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, broadly and roughly falciform, tip narrowed and rounded (Fig. 46); right paramere larger, strongly curving, with slender distal arm, tip of arm not expanded (Fig. 48); male phallosoma slender, tip tapering, rounded (Fig. 47). *Female subgenital plate* roughly trapezoidal, symmetrical, posterior margin with weak medial concavity, small hair tufts present behind posterior margin to either side of medial concavity (Fig. 62).

Macropterous form. Unknown.

Types. Holotype, brachypterous male, PAPUA NEW GUINEA, **East Sepik Prov.:** rainforest stream nr. Pasam, upper Nagam River drainage, 300 m (984 ft), CL 1798, 10 September 1983, J. T. and D. A. Polhemus (BPBM). Paratypes: PAPUA NEW GUINEA, **East Sepik Prov.:** 1 brachypterous female, same data as holotype (JTPC). **Morobe Prov.:** 1 brachypterous male, D. N. Guinea [=Deutsch New Guinea], Sattelberg [900 m] (det. by Montandon as “*A. papuus* var.,” CAS).

Discussion. This small species was confused by La Rivers (1971) with *Aptinocoris papuus* Montandon, based a specimen determined by Montandon. An examination of the holotype of *A. papuus*, however, shows the two species to be quite distinct (see foregoing discussion under *A. papuus*).

The few specimens examined have all come from moderate elevations in the mountains bordering the north coast of the island, from the Prince Alexander Mountains eastward to the Huon Peninsula (Fig. 72). The two specimens from Pasam, in the Prince Alexander Mountains, were taken from rushing water in a narrow limestone channel with a gravel substrate, mostly shaded by disturbed primary rain forest.

Aptinocoris sedlaceki (La Rivers) **new combination**

Figs. 58–60, 65, 73

Sagocoris sedlaceki La Rivers, 1971: 47.

Diagnosis. This moderate sized species may be recognized by its somewhat elongate form, the weak asymmetry of the female abdominal paratergites (Fig. 65), the shape of the female subgenital plate (Fig. 65), and the structure of the male genitalia. It is most similar to *A. papuus*, which is smaller, usually lacks female abdominal asymmetry (Fig. 64), and has a male left paramere with a more produced and elongate tip (Figs. 52, 54), in comparison to the reduced, truncate shape seen in *A. sedlaceki* (Figs. 58, 60).

Material examined. PAPUA NEW GUINEA, **Morobe Prov.:** 1 brachypterous female, Lae Bubia, 23 November 1956, E. S. Brown (holotype, BMNH); 18 brachypterous males, 17 brachypterous females, 3 immatures, 39 km SW of Lae along Wau Road, CL 1813, 15 September 1983, J. T. and D. A. Polhemus (JTPC). **East Sepik Prov.:** 5 macropterous males, 3 macropterous females, 1 brachypterous male, 3 brachypterous females, 1 immature, Nagam River, 3 km S of Pasam, 10 September 1983, CL 1799, D. A. and J. T. Polhemus (JTPC); 1 macropterous female, 6 brachypterous males, 2 brachypterous females, 1 immature, Nagam River, 17 mi SE of Wewak, 6 July 1969, I. La Rivers (CAS). INDONESIA, **Irian Jaya Prov.:** 4 brachypterous males, 2 brachypterous females, Joka, Lake Sentani, 140°37'24"E, 2°36'24"S, 20 October 1954, L. D. Brongersma c. s. (RNHL, CAS); 1 brachypterous female, 1 immature, Jaka Gy, Hollandia [Jayapura], 27 December 1953, L. van der Hammen (RNHL); 1 macropterous male, 3 brachypterous males, 8 brachypterous females, cobble bottomed overflow channel adjoining Tirawiwa River, 0.5 km W of PTFI Siewa exploration camp, 3°02.66'S, 136°22.34'E, 60 m (200 ft), water temp. 28°C, 3 April 1998, 12:00–15:15 hr, CL 7086, D. A. Polhemus (USNM); 1 brachypterous male, 8 brachypterous females, rainforest stream approx. 0.5 km E of PTFI Siewa exploration camp, 3°02.14'S, 136°22.66'E, 60 m (200 ft), water temp. 26°C, 5 April 1998, 08:00–11:00 hr, CL 7089, D. A. Polhemus (USNM).

Discussion. This is a moderate sized species occurring in the northern coastal ranges of New Guinea, and seems to be somewhat local in its distribution, with scattered records from the Wapoga River drainage eastward to the Huon Gulf (Fig. 73). Specimens from different parts of this range vary in size, with those from Lake Sentani, in Irian Jaya, being smaller than those taken near the type locality at Lae, in Papua New Guinea, while others from the Siewa area in the upper Wapoga River area of Irian Jaya are larger. Similarly, specimens from the Nagam River, near Wewak, are more contrastingly marked than those from Lae, but once again show no significant morphological differences. Since the male and female genitalia are basically the same across all the above populations, they are interpreted to be simply regional variants in the context of this work.

As interpreted above, *Aptinocoris sedlaceki* occurs in a wide range of habitats. These include open, unshaded streams with moderate current and shallow, gravelly riffles, such as the Nagam River or the Tirawiwa River overflow channels, as well as smaller, shaded forest streams, such as those near Siewa and Lae. At the latter locality the series was taken from beneath submerged logs swept by the current.

Several specimens in the above series from RNHL and CAS bear La Rivers labels reading "*Sagocoris soldus* PARATYPE," a name that has no validity.

Aptinocoris cheesmanae (La Rivers) **new combination**

Figs. 55–57, 63, 72

Sagocoris cheesmanae La Rivers, 1971: 44.

Diagnosis. This species may be recognized by the structure of the female subgenital plate (Fig. 63) and male genitalia (Figs. 55–57).

Material examined. INDONESIA, **Irian Jaya Prov.:** 1 male, 2 females, Waigeo Island, Camp Nok, 760 m, (2,500 ft), April, 1938, L. E. Cheesman (JTPC, CAS).

Discussion. This is a moderately large species that appears to be endemic to Waigeo Island, which lies offshore of New Guinea proper to the northwest of the Vogelkop Peninsula (Fig. 72). It is known only from the short original type series collected by Cheesman, and no information is available regarding its habitat preferences.

The one female in the California Academy of Sciences bears the La Rivers label "*Sagocoris orthus* PARATYPE," a name that has no validity.

Aptinocoris fenneri (La Rivers) **new combination**

Figs. 40–42, 66, 73

Sagocoris fenneri La Rivers, 1971: 49.

Diagnosis. This species is similar to *A. boikiki*, sharing a pronounced asymmetry of abdominal paratergites V and VI in females. It may be separated from that species by its smaller size (overall length less than 9.0 mm), and differing structure of the female subgenital plate (Fig. 66) and male genitalia (Figs. 40–42).

Material examined. PAPUA NEW GUINEA, **Central Prov.:** 4 macropterous females, 29 brachypterous males, 14 brachypterous females, 3 immatures, Musgrave (Aieme) River at Awarere Plantation, 22 September 1983, CL 1841, J. T. and D. A. Polhemus (JTPC); 1 macropterous male, 1 brachypterous female, stream nr. Musgrave River, 22 September 1983, CL 1842, J. T. and D. A. Polhemus (JTPC); 6 brachypterous males, 3 brachypterous females, Bworogo Creek, 12 km E of Sogeri, 500 m (1,640 ft), 22 September 1983, CL 1843, J. T. and D. A. Polhemus (JTPC); 1 brachypterous female, Laloki River nr. Sogeri, 22 September 1983, CL 1844, J. T. and D. A. Polhemus (JTPC); 6 macropterous males, 5 macropterous females, 13 brachypterous males, 11 brachypterous females, 4 immatures, Laloki River, 15 km N of Port Moresby, 23 September 1983, CL 1845, J. T. and D. A. Polhemus (JTPC); 5 brachypterous males, 7 brachypterous females, Crystal Rapids, nr. Sogeri River, 25 August 1985, J. W. Ismay and S. Langley (JTPC); 1 brachypterous male, 1 brachypterous female, Port Moresby, 21 June 1969, I. La Rivers (paratypes, JTPC).

Discussion. *Aptinocoris fenneri* appears to be confined to the southern section of the Papuan Peninsula (Fig. 73), and is moderately abundant in rocky streams near Port Moresby. The species sometimes occurs in company with *A. sogeri*, but the two species appear to segregate habitats; at the Musgrave River, *A. fenneri* was found in a shallow tributary to the main river with a gravel bottom and moderate current speed, whereas *A. sogeri* occurred in the larger, deeper main river, where it was found among rocks at the heads of swift riffles.

***Aptinocoris boikiki* new species**

Figs. 38, 39, 43–45, 61, 74

Diagnosis. This species, the largest known in the genus, is closely related to *A. fenneri*, but may be separated by its larger size (body length exceeding 10 mm), and differences in the structure of the female subgenital plate (compare Figs. 61, 66) and male genitalia (compare Figs. 43–44, 40–42). Both *A. boikiki* and *A. fenneri* share a pronounced asymmetry of the female abdomen, with left side paratergites V and VI being enlarged and prolonged (Figs. 61, 66).

Description. *Brachypterous form.* Large for genus, form ovate, basic coloration dull yellowish brown with scattered dark brown or black markings on head, thorax, and dorsal abdomen; hemelytra and scutellum predominantly brown. Male length 10.10, maximum width (across abdomen) 6.00; female length 10.25, maximum width 6.00. *Head* dark yellowish brown, with paired longitudinal stripes medially to either side of midline, width/length = 2.90/1.60; eyes brown, shining, width/length = 0.60/1.05, inner margins convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 1.50/1.65, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, segments III and IV filiform (Fig. 38), not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 5.30/2.00, lateral margins narrowly glabrous, broadly arcuate, posterolateral angles acute, posterior margin bisinuate. *Scutellum* dark brown, width/length (midline) = 2.80/1.40, lateral margins sinuate, transverse sulcus present along anterior margin. *Hemelytra* dark brown, lighter brown narrowly bordering scutellum, along claval commissure, and on basal $\frac{3}{4}$ of embolium, each hemelytron also with two small dark yellow spots, one near inner posterior margin of embolium, another at posteromedial apex of corium, surface of corium coarsely rugose; membrane extremely reduced, obscure; tips of hemelytra truncate, extending to middle to abdominal tergite IV; embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae. *Abdomen* with all visible tergites uniformly dark yellowish laterally, becoming embrowned centrally; posterolateral angles of all tergites bearing slender tufts of elongate gold setae; posterolateral angles of segment III in both males and females not produced or spinose, posterolateral angles of segments IV and V in both sexes weakly produced and angulate; posterolateral angles of segments VI–VIII in male acutely angulate, symmetrical, with tips slightly produced, posteromedial portion of male tergite V weakly asymmetrical, with a small central notch offset slightly to right of center as viewed from above (Fig. 39); segments V and VI of female strongly asymmetrical, posterolateral angles produced, acuminate, and spinose on left side (Fig. 61), posterolateral angles of segments VII and VIII symmetrical, angulate. *Ventral surface* light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick re-

cumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially. *Legs* dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing single row of short reddish spines ventrally, terminating in a single large glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with two transverse rows of 4–7 stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, roughly triangular, tip rounded (Fig. 43); right paramere larger, curving, with an elongate distal arm, tip of arm slightly expanded (Fig. 45); male phallosoma with tip elongate (Fig. 44). *Female subgenital plate* roughly trapezoidal, symmetrical, posterior margin broadly and shallowly concave, with small hair tufts behind posterior margin to either side of central concavity (Fig. 61).

Macropterous form. Unknown.

Types. Holotype, brachypterous male: PAPUA NEW GUINEA, **Northern Province**, Boikiki, fast river, 26 July 1985, J. W. Ismay (BPBM). Paratypes: PAPUA NEW GUINEA, **Northern Prov.**: 23 brachypterous males, 28 brachypterous females, 8 immatures, same data as holotype (JTPC, BPBM).

Discussion. This species is known only from the northern section of the Papuan Peninsula (Fig. 74). No information is available regarding its habitat preferences, except for the collector's note that it was taken from a "swift river."

***Aptinocoris sogeri* new species**

Figs. 36, 37, 49–51, 67, 74

Diagnosis. This species is similar in general appearance to *A. boikiki* and *A. fenneri*, but may be separated by the lack of abdominal asymmetry in the female (Fig. 67), and the distinctive male genitalia (Figs. 49–51). *Aptinocoris sogeri* occurs sympatrically with *A. fenneri* in upland streams near Port Moresby, but may be separated from that species in the field by its larger size.

Description. *Brachypterous form.* Of large size for genus, form ovate (Fig. 36), basic coloration dull yellowish brown with scattered dark brown or black markings. Male length 10.40, maximum width (across abdomen) 6.00; female length 10.30, maximum width 6.10. *Head* dark yellowish brown, with paired longitudinal stripes medially to either side of midline, width/length = 3.00/1.70; eyes black, shining, width/length = 0.60/1.20, inner margins convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 1.40/1.80, lateral flange small, glabrous; posterior margin of vertex weakly and

broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* dark yellowish, mottled centrally with dark brown at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 5.40/2.10, lateral margins arcuate, posterolateral angles acute, posterior margin bisinuate. *Scutellum* dark brown, width/length (midline) = 2.50/1.45, lateral margins sinuate, transverse sulcus present along anterior margin. *Hemelytra* dark brown, lighter brown narrowly bordering scutellum, along claval commissure, and on basal $\frac{3}{4}$ of embolium, each hemelytron also with two small dark yellow spots, one near inner posterior margin of embolium, another at posteromedial apex of corium; surface of corium coarsely rugose, membrane reduced, obscure, hemelytra truncate posteriorly, extending only to middle of abdominal tergite IV, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing fringe of long recumbent gold setae. *Abdomen* with all visible tergites uniformly dark yellowish laterally, becoming embrowned centrally; posterolateral angles of all tergites bearing slender tufts of elongate gold setae; posterolateral angles of segments II–IV in both males and females not produced or spinose; posterolateral angles of segments V–VII in male acutely angulate, symmetrical, posterolateral angles of segment VIII rounded, posteromedial portion of male tergite V very weakly asymmetrical, with a small central notch offset slightly to right of center as viewed from above; segments V–VII of female symmetrical, posterolateral angles of segment V–VII sharply angulate, posterolateral angles of segment VIII rounded (Fig. 67). *Ventral surface* light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, coming to acute subconical point anteromedially, this point separated by transverse sulcus from broad tumescence posteromedially. *Legs* dark yellowish, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing single row of short reddish spines ventrally, terminating in a single large glabrous tubercle distally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Male genitalia* with parameres asymmetrical; left paramere small, roughly triangular, tip elongate and rounded (Fig.

49); right paramere larger, curving, with slender distal arm, tip of arm not expanded (Fig. 51); male phallosoma with tip slender, rounded (Fig. 50). *Female subgenital plate* roughly trapezoidal, symmetrical, posterior margin broadly and shallowly concave, with small hair tufts behind posterior margin to either side of central concavity (Fig. 67).

Macropterous form. Similar to brachypterous form in general structure and coloration, with following exceptions: male length 10.10, maximum width 5.80; macropterous female unknown; pronotum slightly expanded, posterolateral angles less acute; scutellum weakly raised; hemelytra with claval and embolar sutures well defined; membrane fully developed, reaching to base of genital segment, lacking evident venation.

Types. Holotype, brachypterous male: PAPUA NEW GUINEA, **Central Prov.**, Eio Creek, nr. Baruanumu, 22 September 1983, CL 1840, D. A. and J. T. Polhemus (BPBM). Paratypes: PAPUA NEW GUINEA, **Central Prov.**: 1 macropterous female, 4 brachypterous males, 3 brachypterous females, same data as holotype (JTPC); 1 brachypterous male, 3 brachypterous females, Musgrave (Aieme) River at Awarere Plantation, 22 September 1983, CL 1841, J. T. and D. A. Polhemus (JTPC); 1 macropterous male, stream nr. Musgrave River, 22 September 1983, CL 1842, J. T. and D. A. Polhemus (JTPC); 1 brachypterous male, Bworogo Creek, 12 km E of Sogeri, 500 m (1,640 ft), 22 September 1983, CL 1843, J. T. and D. A. Polhemus (JTPC).

Discussion. This species is known only from the southern section of the Papuan Peninsula (Fig. 74). Individuals were taken amid stones in areas of moderately swift current, sometimes in company with *A. fenneri* (see previous discussion under that species).

***Aptinocoris ziwa* new species**

Figs. 68, 70, 74

Diagnosis. Distinguished by its small size (length 7.00 mm) and distinctive female subgenital plate (Fig. 70); known from only a single female.

Description. *Brachypterous female.* Small for genus, form ovate, basic coloration golden brown with darker brown markings on head, pronotum, scutellum and hemelytra. Female length 7.00, maximum width 3.40. *Head* pale yellowish brown, with broad longitudinal darker brown stripe medially along midline, width/length = 1.80/1.20; eyes black, shining, width/length = 0.37/0.80, inner margins convergent anteriorly, separated from vertex by shallow furrows, anterior/posterior interocular width = 1.00/1.25, lateral flange small, glabrous; posterior margin of vertex weakly and broadly rounded, weakly produced behind eyes; anteclypeus with anterior margin broadly rounded, barely projecting ahead of eyes, produced beyond labrum for distance less than length of labrum, with obvious notch above labral base; labrum roughly triangular, rounded distally, dark yellowish brown; rostrum yellowish basally, second segment gold, glabrous, extending beyond labrum; antennae slender, filiform, not extending beyond eye margins, basal segments bearing slender gold setae, segment IV glabrous. *Pronotum* pale yellowish brown, bearing broad darker brown markings to either side of midline at muscle attachments, weakly depressed medially behind vertex, width/length (midline) = 3.25/1.15, lateral margins arcuate, posterolateral angles coming to tiny incipient points, posterior margin bisinuate. *Scutellum*

medium dark brown, width/length (midline) = 2.00/1.15, lateral margins weakly sinuate, transverse sulcus present along anterior margin. *Hemelytra* (Fig. 68) medium dark brown, narrowly yellowish along embolar margin; surface of corium coarsely rugose, membrane reduced, forming small, roughly triangular glabrous tab; hemelytra truncate posteriorly, extending only to middle of abdominal tergite IV, embolium demarcated by deep narrow sinuate furrow along inner margin, posterior margin obscure, lateral margin narrowly glabrous, bearing sparse fringe of long recumbent gold setae. *Abdomen* with all visible tergites uniformly medium golden brown; posterolateral angles of all tergites bearing sparse tufts of slender, elongate gold setae; posterolateral angles of segments II–VII not produced or spinose, symmetrical (Fig. 70). *Ventral surface* light brown, with head, prosternum, mesosternum centrally and abdomen covered with thick recumbent gold hydrofuge pile; mesosternal plate sharply reflexed along anterior margin, forming a rounded tumescence anteromedially, this tumescence separated by transverse sulcus from broader tumescence posteromedially. *Legs* pale yellowish brown, anterior femur with thick pad of gold setae along anterior margin, fringe of long gold setae along posterior margin; anterior tibia slender, gently curving, with short gold setae along inner face; middle and hind coxae each bearing a single large glabrous tubercle distally, lacking rows of short reddish spines ventrally; middle and hind trochanters with narrow longitudinal fringe of short thick gold setae distally on posterior margins; middle and hind femora lacking spines along anterior margins, but bearing continuous longitudinal rows of short sharp spines along posterior margins on dorsal and ventral faces; middle and posterior tibiae and posterior tarsi thickly set with longitudinal rows of stout reddish spines, these spines longer and more dense distally, middle and hind tibiae also with single transverse row of stout spines apically; middle and hind tarsi lacking spines dorsally, bearing longitudinal rows of short reddish spines ventrally; middle and posterior femora, tibiae, and tarsi set with long gold swimming hairs along posterior margins; claws gold, sharply bent. *Female subgenital plate* roughly trapezoidal, symmetrical, posterior margin bifurcate, with deep medial concavity, small hair tufts absent behind posterior margin to either side of medial concavity (Fig. 70).

Brachypterous male. Unknown.

Macropterous form. Unknown.

Types. Holotype, brachypterous female: INDONESIA, **Irian Jaya Prov.**, rocky rain-forest tributary to upper Ziwa River at PTFI Wapoga Alpha drilling camp, 1,050 m (3,500 ft), water temp. 20°C, 18 April 1998, 10:00–17:00 hr, 3°08.69'S, 136°34.42'E, CL 7100, D. A. Polhemus (LIPI).

Discussion. *Aptinocoris ziwa* is a small species, and is superficially similar in general size and aspect to *A. minutus*. It may be easily separated from that species by the structure of the female subgenital plate, which has a deep central concavity along the posterior margin (Fig. 70). The male is currently unknown, so no comparison is possible on the basis of male parameres or other genitalic structures. *Aptinocoris ziwa* may also possibly be confused with smaller specimens of *A. papuus*, but can be separated by its narrower overall body shape, and by the shape of the embolar furrow on the hemelytron, which runs nearly parallel to the hemelytral margin, such that the posterior width of the embolium is less than 1.5 the basal width; in *A. papuus*, by contrast, the embolar furrow curves inward posteriorly, causing an ob-

vious posterior widening of the embolium, with its posterior width being over 2.0 times its basal width (compare Figs. 68, 69).

The only known specimen of *A. ziwa* was taken from a small, clear, swiftly flowing tributary stream to the upper Ziwa River, shaded by a canopy of primary montane rain forest. The specimen was captured by disturbing small rocks and gravels swept by the midstream current, and occurred in company with other naucorid species in the genera *Tanycricos* and *Idiocarus*, and large, predaceous baetid mayfly immatures.

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The following curators kindly provided loans of specimens held under their care (collection abbreviations are those used in the text): W. R. Dolling, British Museum (Natural History), London (BMNH); Paul Arnaud, California Academy of Sciences, San Francisco (CAS); Dr. P. H. van Doesburg, Rijksmuseum Van Natuurlijke Historie, Leiden (RHNL); Dr. V. Ranieri, Museo di Storia Naturale "Giacomo Doria," Genoa (MSNG). Holotypes of all new species described herein are deposited in the Bishop Museum, Honolulu (BPBM), or the Indonesian Institute of Sciences, Cibinong (LIPI); paratypes are held in the U. S. National Museum of Natural History, Washington, D.C. (USNM), the J. T. Polhemus collection, Englewood, Colorado (JTPC), and where possible have also been distributed to the institutions noted above.

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LITERATURE CITED

- La Rivers, I. 1971. Studies of Naucoridae (Hemiptera). Biol. Soc. Nevada Mem. 2:1-120.
 Montandon, A. L. 1897. Hemipteres-Heteropteres exotiques. Notes et descriptions. Annales Soc. Entomol. Belgique, 41:50-66.

- Montandon, A. L. 1911. Deux genres nouveaux d'Hydrocorises. Annales Musei Nationalis Hungarici 9:244–250.
- Polhemus, D. A. and J. T. Polhemus. 1989. Naucoridae (Heteroptera) of New Guinea. IV. A revision of the genus *Cavocoris* with descriptions of four new species. J. New York Entomol. Soc. 97:73–86.
- Stys, P. and A. Jansson. 1988. Check-list of recent family-group and genus-group names of Nepomorpha (Heteroptera) of the world. Acta Entomol. Fennica 50:1–44.

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APPENDIX 1. Checklist of taxa currently held in the tribe Sagocorini.

Taxon	Remarks
<i>Aptinocoris</i>	
<i>boikiki</i> D. Polhemus and J. Polhemus	New species
<i>cheesmanae</i> (La Rivers)	New combination
<i>fenneri</i> (La Rivers)	New combination
<i>minutus</i> D. Polhemus and J. Polhemus	New species
<i>papuas</i> Montandon	
<i>sedlaceki</i> (La Rivers)	New combination
<i>sogeri</i> D. Polhemus and J. Polhemus	New species
<i>ziwa</i> D. Polhemus and J. Polhemus	New species
<i>Sagocoris</i>	
<i>asymmetricus</i> (La Rivers)	New combination
<i>biroi</i> Montandon	
<i>flavinotum</i> D. Polhemus and J. Polhemus	New species
<i>gressitti</i> La Rivers	
<i>intermedius</i> D. Polhemus and J. Polhemus	New species
<i>irianus</i> d. Polhemus and J. Polhemus	New species
<i>lariversae</i> La Rivers	
<i>Cavocoris</i>	
<i>bisulcus</i> La Rivers	
<i>ibatiri</i> D. Polhemus and J. Polhemus	
<i>ismayi</i> D. Polhemus and J. Polhemus	
<i>minor</i> D. Polhemus and J. Polhemus	
<i>rotundatus</i> D. Polhemus and J. Polhemus	
<i>Warisia</i>	
<i>cavanceps</i> La Rivers	
<i>Quadricoris</i> La Rivers	Synonym of <i>Sagocoris</i>
<i>Sagocoris browni</i> La Rivers	Synonym of <i>Aptinocoris papuas</i>
<i>Truncocoris</i>	Synonym of <i>Aptinocoris</i>
<i>Margodes</i>	Invalid category (supergenous)
<i>Margallus</i>	Invalid category (supergenous)

DESCRIPTION OF THE IMMATURE STAGES, ADULT MORPHOLOGY AND BIOLOGY OF *PANTOCHLORA VIVIDA* STÅL (HETEROPTERA: PENTATOMIDAE: EDESSINAE)

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Abstract.—The life cycle of *Pantochlora vivida* Stål is reported for first time. Descriptions and illustrations of adult and immature stages are made. Characteristics of the adult genitalia and some ontogenetic characters support placement of *Pantochlora* in the pentatomid subfamily Edessinae. *P. vivida* feeds almost exclusively on new shoots and leaves of several species of two closely related genera of Leguminosae, *Lonchocarpus* and *Piscidia*. Its geographical distribution is restricted to southern Mexico and Central America.

The subfamily Edessinae, in which *Pantochlora vivida* Stål is included, is represented only by phytophagous species of Neotropical distribution (Rolston and McDonald, 1979). The genus *Pantochlora* was described by Stål (1870), who included one species, *P. vivida* from Campeche, Mexico. He related this genus with *Piezosternum* because of similarities on the metasternal spine and placed both genera in the division Piezosternaria. Distant (1880-1893) placed *P. vivida* in the subfamily Tessaratominae, but Horváth (1900) created the tribe Pantochlorini in which he placed *P. vivida*. Blöte (1945) also considered *P. vivida* within the same categories. Leston (1955) suggested the possible relationship of Pantochlorini with Edessini based on the male and female genitalia. Kumar (1969), on the basis of the same characters, transferred Pantochlorini to Pentatomidae. Kumar & Ghauri (1970) raised the subfamily Tessaratominae to family level and placed Pantochlorini in the family Tessaratomidae. Pirán (1971) reviewed the Neotropical Tessaratominae, including *P. vivida*. Finally Rolston & McDonald (1979) elevated Edessini to subfamily level including *Pantochlora* in it. In the present study *Pantochlora vivida* is redescribed, and its life history stages are described and illustrated for first time. Host plants and biology of the species are also discussed.

MATERIALS AND METHODS

The present study was based mainly on individuals deposited in the Entomological Collection of the Instituto de Biología, U.N.A.M., Mexico, and in the entomological collections of the two field stations belonging to the Instituto de Biología ("Los Tuxtlas," Veracruz and Chamela, Jalisco). Material deposited in The Natural History Museum in London, England, was also checked. A total of 155 females, 111 males, 138 nymphs, and 76 eggs were studied.

Most of the biological information was obtained from a series of field studies conducted between 1985 and 1989 in "Los Tuxtlas", Veracruz, Mexico. Ten day

monthly visits were made during 1985 and 1986 and more irregular visits were made during 1987–1989. Some other biological data and host plants were recorded from different field trips around Mexico, and from specimens deposited in the collections.

On each field trip, several areas were sampled. The host plants are common on road sides and paths, and abundant at the edges of sites in primary forest that have been cleared for agriculture or grazing purposes and in other zones of secondary vegetation. On each visit during the first two years, the same roads and edges were sampled, investing around 60 hr each month to check all the plants in these areas. Insects were collected alive and placed in plastic containers (11 × 11 cm) covered with muslin to avoid condensation and fungal growth. Containers were maintained under laboratory conditions at around 20°C and 70% RH. Insects were supplied with host plants and on some occasions green beans were offered as a substitute. Containers were checked daily and presence of eggs and changes in individuals recorded. Several individuals of each stage were fixed in 70% alcohol for illustration and description. Ten individuals of each stage were measured (measurements are given in mm), and used for descriptions.

Pantochlora vivida Stål, 1870

(Figs. 1–18)

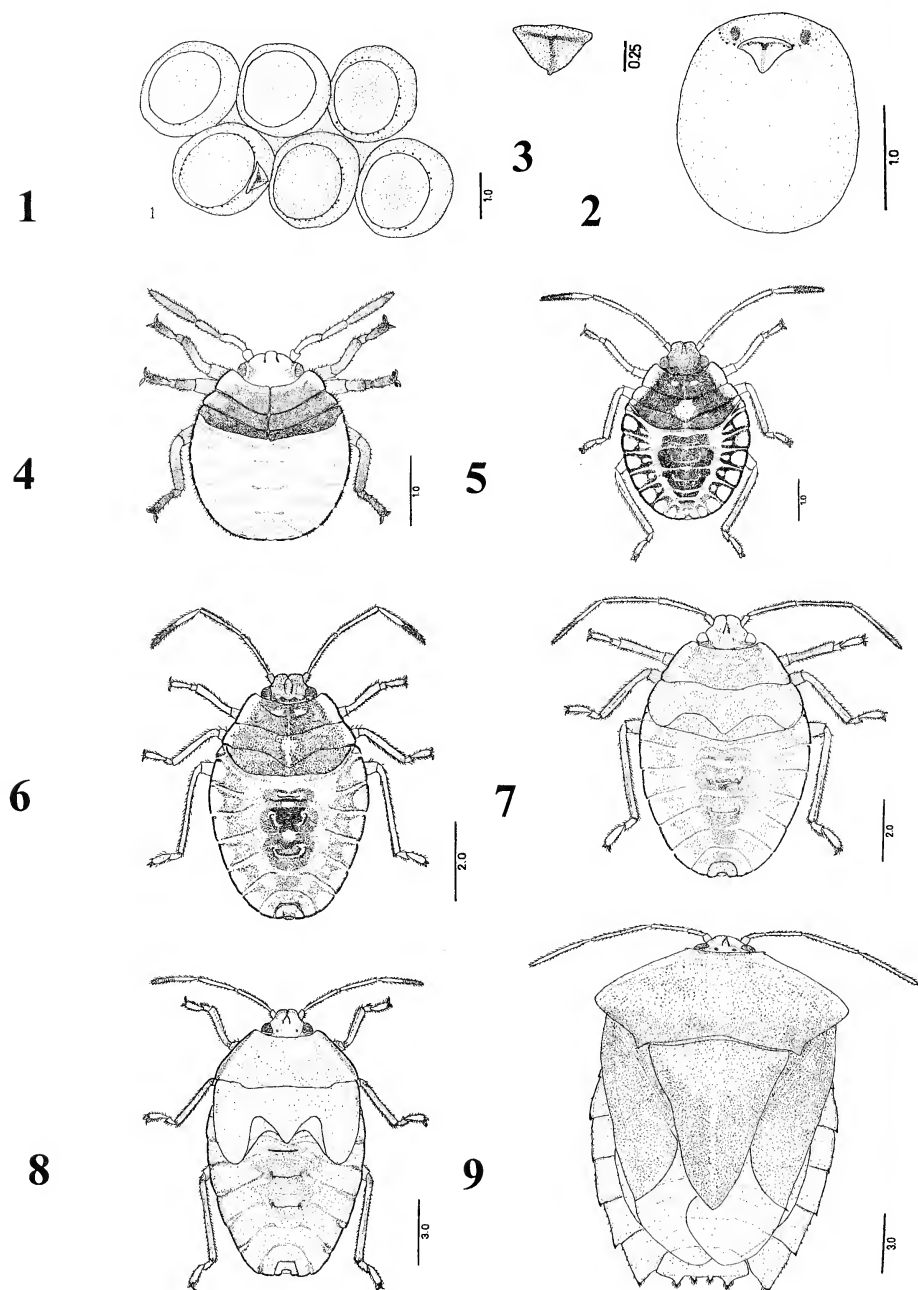
Pantochlora vivida Stål, 1870. *Svensk. Vet. Ak. Hand.* 9: 65

Pantochlora vivida: Distant, 1881. *Biol. Centr. Amer. Rhynch.* 1: 102, 351

Pantochlora vivida: Kirkaldy, 1909. *Cat. Cimic.* b: 358

Egg (Figs. 1–3). Barrel shaped, yellow when laid, becoming green in two or three days; chorion smooth, with few punctations; pseudoperculum with 36 to 40 micropylar projections. Females always laid masses of 14 eggs arranged in two regular lines (egg masses = 6). *Allometries*. Egg length 1.80 ± 0.06 ; egg width 1.63 ± 0.04 ; micropylar projection length 0.02 ± 0.004 ; egg burster length 0.70 ± 0.06 ; egg burster width 0.43 ± 0.02 (N = 10).

First Instar (Fig. 4). Oval, convex dorsally, maximum width around abdominal segment II; margin of body with numerous setae projecting upwards. Head, antennae, rostrum, and legs light brown; base of eye with or without dark brown spot; eye bright red. Pronotum, mesonotum, and metanotum dark brown, lateral border light brown; margins of thorax and abdominal segments black. Abdomen yellow-brown, red marks delimiting each segment and around each lateral plate; middle plates inconspicuous on segments III–IV, IV–V and V–VI; scent glands with dark margin. Ventral surface of body yellow. *Head*. Angled and embedded in pronotum; tylus and juga not visible in dorsal view; eyes sessile and longer than frontal angles; tylus slightly shorter than juga; antenna with four segments, the fourth longest; rostrum extended to metacoxa. *Thorax*. Anterior margin of pronotum strongly concave; posterior border convex; lateral margins rounded; mesonotum and metanotum with anterior margin concave and posterior one convex; lateral plates slightly triangular; plate I conspicuously small, plates increasing in size to the fourth and then reduced in size; scent glands on segments III–IV, IV–V and V–VI, the first one very small and long, remaining two evident and ellipsoidal. *Allometries* (N = 10). Body length 2.58 ± 0.08 ; body width 2.46 ± 0.07 ; head length 0.44 ± 0.01 ; head width 0.99 ± 0.02 ; interocular distance 0.66 ± 0.02 ; antennal segments: I 0.22 ± 0.02 , II $0.39 \pm$



Figs. 1-9. *Pantochlora vivida* Stål. 1, Egg mass. 2, Single egg showing egg buster and eyes. 3, Egg buster. 4, First instar nymph. 5, Second instar nymph. 6, Third instar nymph. 7, Fourth instar nymph. 8, Fifth instar nymph. 9, Adult.

0.01, III 0.46 ± 0.06 , IV 0.78 ± 0.06 ; rostral segments: I 0.25 ± 0.01 , II 0.34 ± 0.03 , III 0.25 ± 0.03 , IV 0.29 ± 0.06 ; pronotum length 0.39 ± 0.06 ; humeral width 1.70 ± 0.05 ; frontal width 1.11 ± 0.11 ; femur 0.85 ± 0.05 ; tibia 0.84 ± 0.04 ; tarsi: I 0.24 ± 0.01 , II 0.40 ± 0.02 .

Second Instar (Fig. 5). Oval, flattened dorsoventrally; margins of pronotum, mesonotum, metanotum, and lateral plates serrated and densely setose; dorsal punctations present. Head with numerous dark brown punctations; anterior half pale yellow, posterior half dark brown; antennal segments I and II yellow, III with distal half light brown and IV with distal half dark brown; rostrum yellow-brown with apex dark brown. Pronotum, mesonotum, and metanotum with numerous dark brown punctations, except transparent lateral borders. Pronotum with white spot on each side of midline; metanotum with yellow-brown spot in middle and a pair of smaller yellow-brown spots adjacent. Thoracic pleura with yellow and dark brown spots; legs yellow, femur slightly darker than other segments. Lateral plates punctate, delimited by dark brown area; middle plates dark brown and punctate; dorsal sutures red; ventral surface yellow. *Head*. Apex slightly square; juga longer than tylus, joining in front of it; rostrum extended beyond metacoxa; eye kidney shaped. *Thorax*. Mesonotum with lateral margins elevated; metanotum slightly reduced at middle and at lateral margins; glands opening between propleura and mesopleura, and between mesopleura and metapleura. *Abdomen*. First lateral plate triangular, others with an area of punctations resembling an "A"; middle plates on segments III–IV, IV–V, V–VI, VII, and VIII; first three with senescent openings, middle plates I and II rectangular; III slightly compressed at middle, plates IV and V small and irregular; spiracle on sternum II–VIII and a pair of trichobothria below spiracles II to VII. *Allometries* (N = 10). Body length 3.84 ± 0.1 ; body width 3.39 ± 0.08 ; head length 0.67 ± 0.02 ; head width 1.33 ± 0.02 ; interocular distance 0.85 ± 0.03 ; antennal segments: I 0.26 ± 0.04 , II 1.0 ± 0.03 , III 1.97 ± 0.05 , IV 1.43 ± 0.05 ; rostral segments: I 0.39 ± 0.03 , II 0.51 ± 0.04 , III 0.28 ± 0.04 , IV 0.36 ± 0.04 ; pronotum length 0.58 ± 0.07 ; humeral width 2.32 ± 0.07 ; frontal width 1.44 ± 0.13 ; femur 1.57 ± 0.05 ; tibia 1.69 ± 0.09 ; tarsi: I 0.32 ± 0.01 , II 0.50 ± 0.03 .

Third Instar (Fig. 6). Body oval, flattened dorsoventrally; maximum width through abdominal segment II; thoracic margins serrated, fine setae only around the last abdominal segments. Very similar to second instar in most characters. Dark brown areas yellow on almost entire body except lateral margins, middle plates, and base of head; white spots of pronotum slightly evident; white spots on apex of lateral plates and on anterior region of lateral plates I–III; rostrum extended to mesocoxa; scutellum extended to metanotum. *Allometries* (N = 10). Body length 6.35 ± 0.17 ; body width 4.63 ± 0.1 ; head length 0.96 ± 0.03 ; head width 1.79 ± 0.04 ; interocular distance 1.06 ± 0.03 ; antennal segments: I 0.38 ± 0.03 , II 1.47 ± 0.04 , III 1.52 ± 0.04 , IV 1.84 ± 0.05 ; rostral segments: I 0.57 ± 0.04 , II 0.64 ± 0.03 , III 0.37 ± 0.04 , IV 0.43 ± 0.04 ; pronotum length 0.86 ± 0.07 ; humeral width 3.34 ± 0.08 ; frontal width 1.98 ± 0.1 ; femur 2.30 ± 0.06 ; tibia 2.47 ± 0.06 ; tarsi: I 0.43 ± 0.04 , II 0.70 ± 0.04 .

Fourth Instar (Fig. 7). Oval, slightly convex dorsally; maximum width through abdominal segment II. Head, thorax, lateral, and middle plates yellow-orange with brown punctures; lateral margin of pronotum, mesonotum, and metanotum dark brown; posterior part of eyes white; coxa, femur, and tibia red-orange; tarsi yellow.

Head. Juga longer than tylus; rostrum extended to mesocoxa. *Thorax.* Anterior margin of pronotum concave; lateral margins straight and slightly serrated; posterior margin sinuated; mesonotum with round lateral margins covering part of metanotum. *Hemelytra.* Wing pads evident, wider than long, reaching abdominal segment II; scutellum extended to base of metanotum; metasternal spine evident extended to mesosternum and with small middle groove; first abdominal lateral plate almost completely covered by wing pads. *Allometries* ($N = 10$). Body length 8.92 ± 0.24 ; body width 6.44 ± 0.14 ; head length 1.22 ± 0.04 ; head width 2.22 ± 0.07 ; interocular distance 1.25 ± 0.03 ; eye-ocellus distance 0.22 ± 0.04 ; antennal segments: I 0.46 ± 0.03 , II 1.82 ± 0.03 , III 1.90 ± 0.05 , IV 2.42 ± 0.07 ; rostral segments: I 0.76 ± 0.03 , II 0.86 ± 0.04 , III 0.40 ± 0.06 , IV 0.53 ± 0.05 ; pronotum length 1.29 ± 0.08 ; humeral width 4.83 ± 0.09 ; frontal width 2.40 ± 0.12 ; scuteller length 1.41 ± 0.06 ; scutellar width 3.78 ± 0.15 ; femur 3.08 ± 0.08 ; tibia 3.17 ± 0.05 ; tarsi: I 0.66 ± 0.05 , II 0.87 ± 0.03 .

Fifth Instar (Fig. 8). Oval, convex dorsally, and flattened ventrally; maximum width through abdominal segment II. Pronotum, scutellum, wing pads, metanotum, and middle abdominal plates with dark brown punctures. Lateral margin of pronotum, anterolateral margin of wing pads, and lateral margin of conexivum red. Rest of body yellow. Anterior part of juga and tylus red. Red line on posterior margin of lateral plates I–IV. Posterior margin of segments VII and VIII red. Antenna yellow, segment IV with distal half pale brown; eyes and ocelli red, posterior region of eyes white to pale yellow. Coxa, femur, and tibia yellow-orange; apex of femur and base of tibia red; apex of tibia brown; tarsi yellow-brown. *Head.* Juga longer than tylus and joined in front of it; bucculae slightly elevated, covering part of rostral segment I; rostrum extended to apex of metasternal spine. *Thorax.* Wing pads extended to abdominal segment III; scutellum longer than wide, extended to base of abdominal segment II; with or without a mesosternal groove in which last rostral segment rests; metasternal spine extended to mesocoxa and either long with a middle longitudinal groove and sharp apex or flat with bald apex; in both cases reaching the mesocoxa. *Abdomen.* Abdominal segment I covered almost completely by wing pads; lateral plates not evident; middle plates evident as more sclerotized areas; spiracle and trichobothria on sternites II–VIII, those on sternite very small; female nymphs with sternite VIII divided by longitudinal line. *Allometries* ($N = 10$). Body length 11.79 ± 0.24 ; body width 7.78 ± 0.12 ; head length 1.48 ± 0.04 ; head width 2.64 ± 0.05 ; interocular distance 1.49 ± 0.04 ; eye-ocellus distance 0.26 ± 0.04 ; antennal segments: I 0.54 ± 0.03 , II 2.18 ± 0.05 , III 2.28 ± 0.06 , IV 2.46 ± 0.07 ; rostral segments: I 1.02 ± 0.04 , II 1.12 ± 0.05 , III 0.55 ± 0.05 , IV 0.66 ± 0.05 ; pronotum length 2.15 ± 0.06 ; humeral width 7.29 ± 0.06 ; frontal width 2.98 ± 0.9 ; scutellar length 2.57 ± 0.1 ; scutellar width 6.0 ± 0.17 ; femur 4.03 ± 0.1 ; tibia 4.01 ± 0.01 ; tarsi: I 0.79 ± 0.02 , II 1.10 ± 0.09 .

Adult (Figs. 9–10). When killed in alcohol, pale yellow, bright green in nature. Eyes red-brown, ocelli red; posterolateral angles of abdominal segments III–VII of males and females and posterior angles of paratergite VIII and IX of females with a black spine; hemelytra translucent; distal half of claws black; sternite III–VI with irregular red-yellow spots around middle spine; spine of sternite III red-yellow and short, joined to the bifid metathoracic spine. *Head.* Wider than long, triangular, inserted in pronotum; surface almost smooth with few striae; width through eyes no greater than

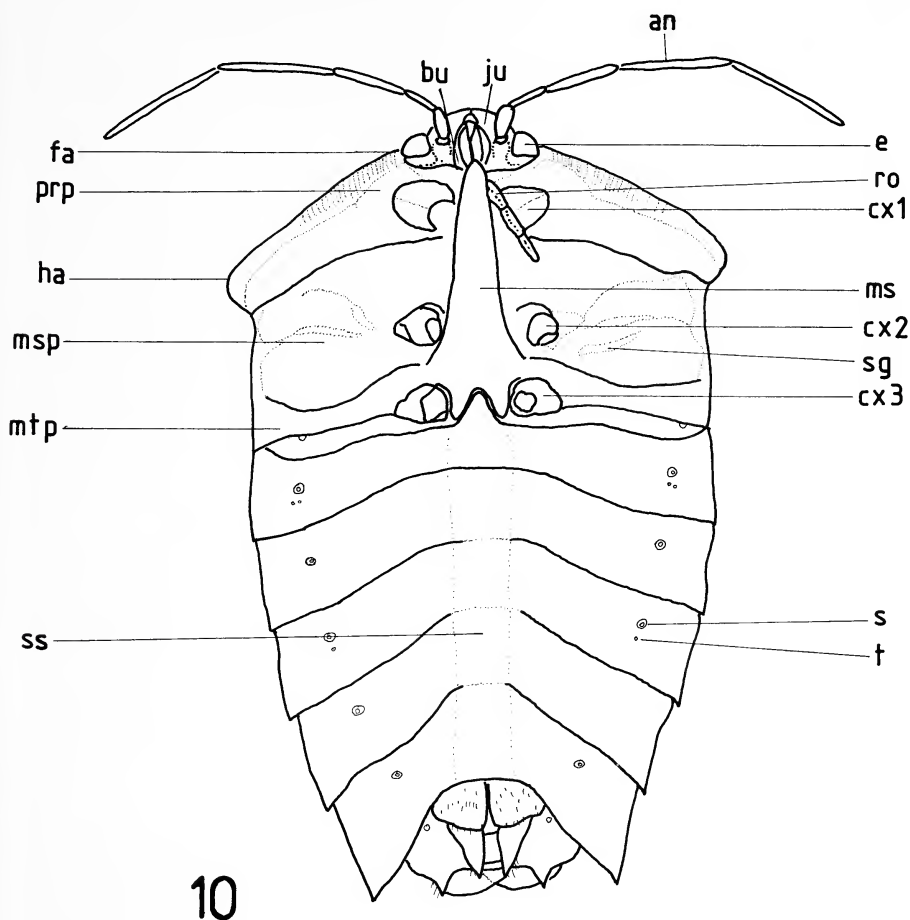
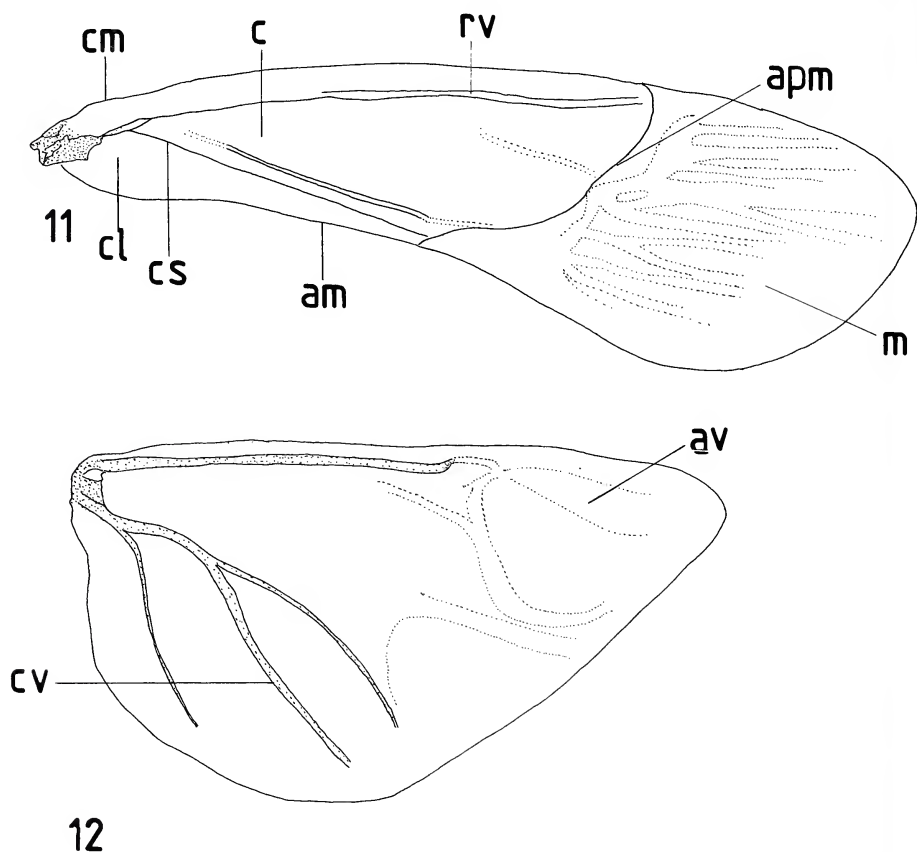


Fig. 10. *Pantochlora vivida* Stål. Ventral view of adult. an = antennae; as = abdominal spine; bu = bucculae; cx1 = procoxa; cx2 = mesocoxa; cx3 = metacoxa; e = eyes; fa = frontal angle; ha = humeral angle; ju = jugum; ms = metasternal spine; msp = mesopleura; mtp = metapleura; prp = propleura; ro = rostrum; s = spiracle; sg = senescence gland; ss = sternal spine; tr = trichobothria.

width through frontal angles; antennal segment I similar or slightly longer than juga, juga longer than tylus and apically rounded; dorsal surface of head with small elevation near base of tylus, sometimes extended to the posterior end of head; eyes kidney shaped; ocellus small, located near border of the elevation of head, distance between ocelli bigger than distance between them and eyes; antennal tubercle short; bucculae well developed, triangular and almost completely obscuring rostral segment I; rostrum directed to one side of metathoracic spine. *Thorax*. Pronotum wider than long; anterolateral margins slightly elevated, without punctures and slightly striated on anterior half near lateral margin; rest of pronotum densely punctate; frontal angles



Figs. 11–12. *Pantochlora vivida* Stål. 11, Frontal wing. 12, Posterior wing. am = anal margin; apm = apical margin; av = apical vein; c = corium; cl = clavus; cm = costal margin; cs = claval suture; cv = cubital vein; m = membrane; pv = primary vein; rv = radial vein.

ending on small spine with round apex; humeral angles exposed slightly sharp; posterolateral margin slightly sinuated; anterior and posterior margins scarcely concave; posterolateral angles sharp, forming a small projection that usually covers part of scutellum and clavus; striated surface of anterolateral margin bent downwards, giving a rounded appearance; propleura, mesopleura, and metapleura densely punctate; orifice of metathoracic peritreme elongated almost reaching border of metapleura; evaporative area encompassing three quarters of metapleura; metasternal spine basally bifid, compressed dorsoventrally near metasternum, slightly elevated near mesosternum, reaching maximum height around procoxae and ending near base of head; legs without spines, foretibia slightly sulcate. Scutellum triangular, longer than wide, reaching abdominal segment VII, and slightly constricted at posterior half. *Hemelytra*. Corium without apparent venation; corium and clavus densely punctate; hemelytral membrane with numerous veins (Figs. 11–12). *Abdomen*. Conexival seg-

ments III–VII visible, with posterolateral angles projected into a spine; sternite II visible only on posterior half; spiraculum present on sternum II–VII, in females also present on sternite VIII; middle spine of sternum III–VI extended anteriorly and joined to bifid base of metasternal spine. *Male allometries* ($N = 10$). Body length 14.48 ± 0.25 ; body width 8.83 ± 0.2 ; head length 1.85 ± 0.05 ; head width 2.68 ± 0.07 ; interocular distance 1.43 ± 0.04 ; eye-ocellus distance 0.25 ± 0.04 ; antennal segments: I 0.54 ± 0.05 , II 0.77 ± 0.05 , III 1.50 ± 0.04 , IV 2.39 ± 0.06 , V 2.73 ± 0.07 ; rostral segments: I 0.97 ± 0.05 , II 1.21 ± 0.06 , III 0.58 ± 0.05 , IV 0.67 ± 0.06 ; pronotum length 4.24 ± 0.06 ; humeral width 8.83 ± 0.19 ; frontal width 2.90 ± 0.09 ; scutellar length 7.84 ± 0.16 ; scutellar width 5.73 ± 0.15 ; femur 4.67 ± 0.12 ; tibia 4.27 ± 0.12 ; tarsi: I 0.67 ± 0.02 , II 0.28 ± 0.01 , III 0.80 ± 0.04 . *Female allometries* ($N = 10$). Body length 15.70 ± 0.19 ; body width 9.74 ± 0.15 ; head length 2.09 ± 0.05 ; head width 2.88 ± 0.06 ; interocular distance 1.58 ± 0.04 ; eye-ocellus distance 0.30 ± 0.05 ; antennal segments: I 0.58 ± 0.04 , II 0.76 ± 0.06 , III 1.63 ± 0.05 , IV 2.54 ± 0.04 , V 2.77 ± 0.08 ; rostral segments: I 1.03 ± 0.03 , II 1.26 ± 0.07 , III 0.72 ± 0.06 , IV 0.79 ± 0.07 ; pronotum length 4.78 ± 0.05 ; humeral width 9.74 ± 0.17 ; frontal width 3.91 ± 0.11 ; scutellar length 8.64 ± 0.14 ; scutellar width 6.36 ± 0.15 ; femur 5.0 ± 0.09 ; tibia 4.58 ± 0.14 ; tarsi: I 0.64 ± 0.03 , II 0.31 ± 0.02 , III 0.84 ± 0.05 .

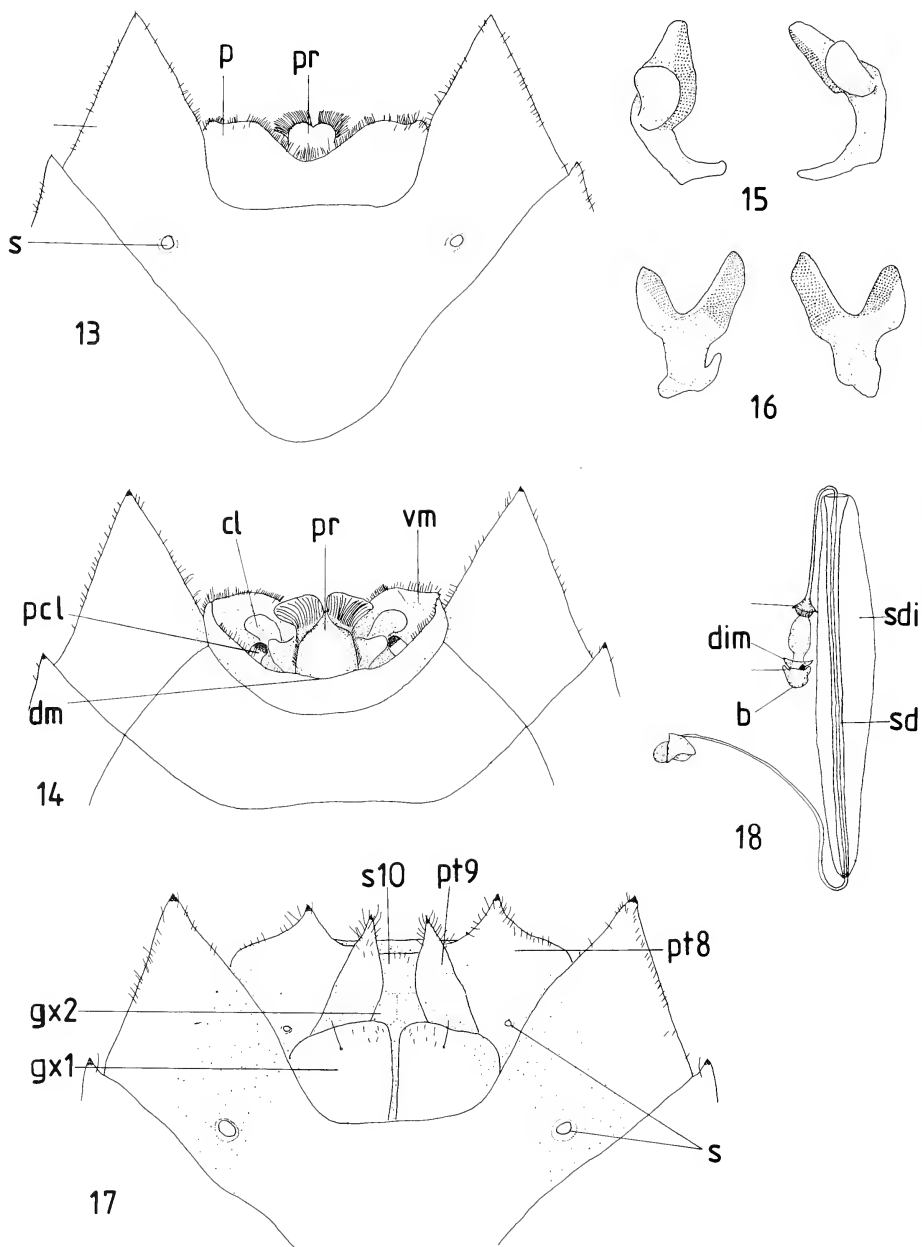
Male Genitalia. Pygophore large, with a depression on posterior margin and two small tubercles at each side of midline of internal side (pseudoclaspers) and visible only in dorsal view. Paramere with narrow base, long and wider towards middle, ending in two flattened wings (Figs. 13–16).

Female genitalia. Spermatheca with spherical bulb with three projections; duct short; chamber long and dilated (Figs. 17–18).

BIOLOGY

Pantochlora vivida Stål feeds exclusively on species of two closely related genera of Fabaceae (=Leguminosae). In the study area (“Los Tuxtlas,” Veracruz, Mexico) it sucks sap from new shoots and leaves of *Lonchocarpus guatemalensis* Benth. and *L. cruentus* Lundell. In other areas it was collected on *Lonchocarpus* spp. and *Piscidia piscipula* (L.) Sang. Adults appear in late February or early March (Fig. 19) and do not reproduce until April when it is common to observe them mating on new shoots of host plants. Nymphs appear in May and can be found until September. The life cycle lasts about 62 days. Adults are most numerous in July. Females under laboratory conditions died three or four days after oviposition. Nymphs are present during all the rainy season (June to September) and *P. vivida* might have two generations per year. The ratio of males to females at “Los Tuxtlas,” Veracruz was 1.24:1.

Females laid eggs on the lower surface of mature leaves, always 14 eggs arranged in two rows of seven ($N = 6$). In the laboratory, eggs were attached to the walls of the container and arranged similarly. After hatching, the first-instar nymphs remained near the eggs without feeding or moving. Second instars moved to new leaves and began to feed. Fifth instars dispersed over the plants and sucked sap from new shoots. When disturbed, nymphs expelled a white substance through their anus or fell to the ground and feigned death.



Figs. 13–18. *Pantochlora vivida* Stål. 13, Terminal abdominal segments of male (ventral view). 14, Terminal abdominal segments of male (dorsal view). 15–16, Different angles of male paramere. 17, Terminal abdominal segments of female (ventral view). 18, Spermatheca. b = bulb; cl = clasper, dm = dorsal margin; dim = distal margin; gx1 = first gonocoxa; p = pygophore; pcl = pseudo-clasper; pm = proximal margin; pr = proctiger; pt8 = paratergite 8; s = spiracle; sd = spermathecal duct; sdi = spermathecal dilation; s10 = sternum 10; vm = ventral margin.

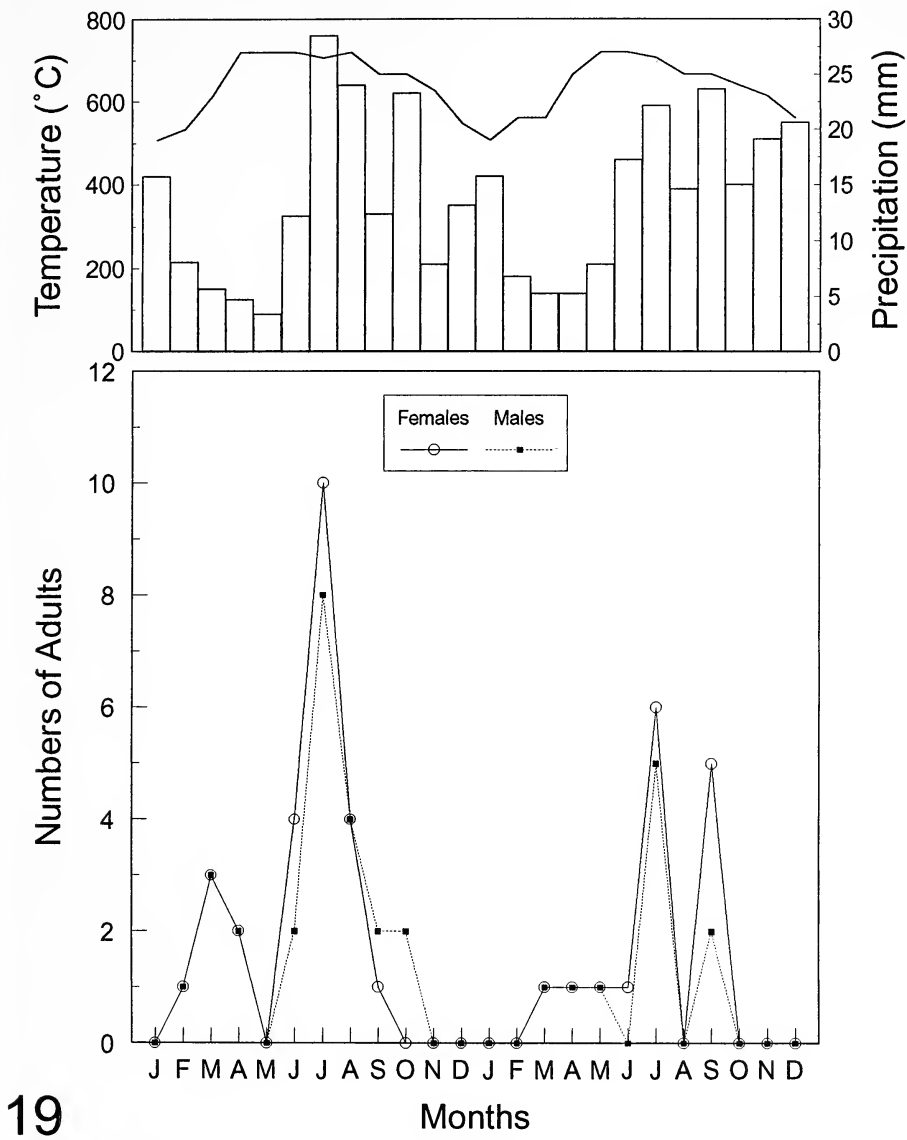


Fig. 19. Numbers of adults of *Pantochlora vivida* Stål collected during 1985 and 1986 in “Los Tuxtlas”, Veracruz, Mexico, and mean temperature and precipitation over the sampling period.

Under laboratory conditions, *P. vivida* was very difficult to rear because of its host specificity; individuals developed only if fed fresh shoots of host plants. Eggs hatched after 5–9 days, the first instar lasting about 8 days; the next instars had a variable duration depending on the supply of food and environmental conditions and lasted approximately 7, 10, 14, and 16 days, respectively. Females died after oviposition ($N = 3$) but one male lived two years.

P. vivida was collected in several areas around Mexico. In Chamela, Jalisco it occurred during June–October and in Chajul, Chiapas, during May–June; in both localities the bugs fed on *Lonchocarpus* spp. Irregular collections at other localities also showed this species to be restricted to the rainy season, which corresponds to the period of the year when its host plants produce new shoots. In Campeche and Quintana Roo, Mexico, *P. vivida* was found during June, feeding exclusively on *Piscidia piscipula* (L.) Sarg.

DISTRIBUTION

Known distribution. MEXICO: Campeche (Stål, 1870). GUATEMALA: La Tinta, Panima, San Joaquin (Distant, 1880–1893). COSTA RICA: La Vruca (Blote, 1945). **New records.** MEXICO: **Jalisco:** Chamela; **San Luis Potosi:** Ciudad Valles, and Micos; **Guerrero:** Acahuizotla, km. 33 Iguala-Teloloapan; **Oaxaca:** Rio Blanco Valle Nacional, Tuxtepec, Arroyo Choapan, Camelia Roja; **Veracruz:** San Andres Tuxtla, "Los Tuxtlas," Atoyac; **Campeche:** Escarcega, Grutas Xtacumbilxunaan, Champoton, El Zapote, 17 km E of La Joya; **Chiapas:** Bonampak, Boca Lacantum, Chajul; **Quintana Roo:** Tulum, Felipe Carrillo Puerto, Laguna Buena Vista, 146 km Chetumal-Puerto Juarez. BELIZE: Salamanca, Punta Gorda. COSTA RICA: Guanacaste, Santa Rosa.

DISCUSSION

The distribution of *Pantochlora vivida* seems to be related to the distributions of its host plants, species of the genera *Lonchocarpus* and *Piscidia*, and to certain environmental conditions (e.g., precipitation, temperature and altitude). It has been found from sea level (Campeche and Quintana Roo) to about 600 m of elevation (Guerrero, Acahuizotla). Vegetation types varied from tropical rain forest to low deciduous forest. Because *Lonchocarpus* has representatives from Mexico to South America (Ponhill, 1986), *P. vivida* might occur throughout the range of *L. guatemalensis*, which includes the Gulf of Mexico to Quintana Roo and Sinaloa to Chiapas on the Pacific coast, as well as Belize to Panama (Ibarra, 1985). This pentatomid's range could also be associated with the distribution of its other hosts. The genus *Piscidia* represented by seven species occurs in the north Neotropics. *Piscidia piscipula* is found in the Greater Antilles and eastern Mexico (Rudd, 1969).

Pantochlora vivida is found only in the area that Brailovsky (1985) proposed as the North American Neotropics, occupying the coastal areas of Mexico and tropical areas of the south of the country, reaching to northern Costa Rica.

In "Los Tuxtlas," Veracruz, the life cycle of *P. vivida* is clearly related to the rainy season when the temperatures are higher (June to October) (Fig. 19). The presence of two generations per year is possible because throughout this period its host plants produce new shoots, which are important for the development of the

early nymphal instars. Adults probably survive until the next year feeding on mature shoots.

As in most pentatomids (Brailovsky et al., 1987; Brailovsky et al., 1992, first instars remain near the eggs, where they probably obtain their microbial symbionts but without feeding on any plant material. Later instars disperse and feed mainly on new leaves and shoots of their hosts.

Only a few insects feed on members of the genera *Lonchocarpus* and *Piscidia*, which contain several compounds used in the elaboration of insecticides. The bark and other parts of the plants contain rotenone and isoflavonoids that have been used for fishing and chemical control of insects (Polhill and Raven, 1981). The compounds in both genera are very similar and Harborne et al. (1971) considered that they are related. No mammals feed on the foliage or seeds of species of the genus *Lonchocarpus* (Janzen et al., 1990). Other insects associated with species of these plant genera are *Acrocinus longimanus* (Cerambycidae) which feeds on *L. spruceanus*, and *Calynda bicuspidata* (Phasmida) which feeds on the leaves of *L. minimiflorus*. In addition, the anthophorids *Centris aethytera* and *C. fuscata* use the pollen and nectar of *L. costaricensis* and *L. minimiflorus*, and *Morpho peleides* (Lepidoptera) lays eggs on the lower side of the leaves of *Lonchocarpus* spp. and the larvae feed on them. Polhill and Raven (1986) reported that *Ctenocolum* spp. (Bruchidae) feed on the seeds of *Lonchocarpus* spp. Other Hemiptera feeding on *L. guatemalensis* and *L. cruentus* are *Lycambes varicolor* and *Stenoscelides* sp. (Coreidae). No parasitoids or predators of *P. vivida* were found in the present study.

Pantochlora vivida has a few ancestral characteristics (venation, spiracle of abdominal segment II visible), although the characteristics of its genitalia correspond to more evolved forms. It probably originated from a group of Tessaratomidae (presumably related to *Piezosternum*). It might have come from South American forms that migrated to the North, when the first Central American bridge was created between Late Cretaceous and Eocene. Differentiation could have occurred in southern Mexico or north of Central America and then have migrated north through the coastal areas of Mexico to Costa Rica. This pattern corresponds to the one proposed by Halfpfer (1964, 1976) for the Mexican plateau.

Morphological similarities in the genitalia and some characteristics of the immature stages of *P. vivida* and several species of Edessini suggest that these two groups are related and that they could have a common origin. Similarities between the two groups are pygophore with pseudoclasps; paramere with similar shapes; spermathecal bulb spherical, with three elongations. Some analogies in ontogenetic characteristics include the development of scent glands and metasternal spine, egg masses of 14 eggs arranged in double rows of seven, the micropylar projections, corium and egg burster. Because of this series of characteristics, it is suggested that *Pantochlora vivida* be retained with Edessinae, as proposed by Rolston and McDonald (1979).

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LITERATURE CITED

- Blöte, H. C. 1945. Catalogue of the Pentatomidae in the Rijksmuseum Van Natuurlijke Histoire. I. Tessaratominae, Urolabidinae. Zool. Meded. 25:308.
- Brailovsky, A. 1985. Revisión del Género *Anasa* Amyot Serville (Hemiptera-Heteroptera-Corredidae-Coreinae-Coreini). Monografías Instituto de Biología Universidad Nacional Autónoma de México 2:1-266.
- Brailovsky, H., L. Cervantes, and C. Mayorga. 1987. Hemiptera-Heteroptera de México XL; La Familia Cyrtocoridae Distant en la Estación de Biología Tropical "Los Tuxtlas" (Pentatomoidea). An. Inst. Biol. Univ. Nal. Auton. Mex. Ser. Zool. 58(2):537-560.
- Brailovsky, H., L. Cervantes, and C. Mayorga. 1992. Hemiptera: Heteroptera de México XLIV. Biología, Estadios Ninfales y Fenología de la Tribu Pentatomini (Pentatomidae) en la Estación de Biología Tropical "Los Tuxtlas", Veracruz. Instituto de Biología Universidad Nacional Autónoma de México Publicaciones Especiales 8. 204 pp.
- Distant, W. L. 1880-1893. Insecta Rhynchota Hemiptera-Heteroptera. Biología Centrali Americana I:102, 351.
- Halfpiter, G. 1964. La Entomofauna Mexicana. Ideas acerca de su origen y distribución. Fol. Entomol. Mex. 6:1-108.
- Halfpiter, G. 1976. Distribución de los insectos en la zona de Transición Mexicana, Relaciones con la Entomofauna de Norteamérica. Fol. Entomol. Mex. 35:1-64.
- Harborne, J. B., D. Boulter, and B. L. Turner. 1971. Chemotaxonomy of Leguminosae. Academic Press, Great Britain, 612 pp.
- Horvarth, G. 1900. Analecta ad Cognitionem Tessaratominorum. Ternez. Fuzetak. 23:339-374.
- Ibarra, M. G. 1985. Estudios Preliminares sobre la Flora Leñosa de la Estación de Biología Tropical "Los Tuxtlas", Veracruz. Tesis. Facultad de Ciencias. Universidad Nacional Autónoma de México, México, 264 pp.
- Janzen, D. H., L. E. Fellows, and P. G. Waterman. 1990. What protects *Lonchocarpus* (Leguminosae) seeds in Costa Rica dry forest? Biotropica 22(3):272-285.
- Kirkaldy, G. W. 1909. Catalogue of the Hemiptera (Heteroptera). Vol. 1. Cimicidae. Berlin.
- Kumar, R. 1969. Morphology and relationships of the Pentatomoidea (Heteroptera). III. Natalicolinae and some Tessaratomidae of uncertain position. Ann. Entomol. Soc. Am. 62(4): 681-695.
- Kumar, R. and M. S. K. Ghauri. 1970. Morphology and relationships of the Pentatomoidea (Heteroptera). 2. World genera of Tessaratomini (Tessaratomidae). Deut. Entomol. Z. 17(1-3):1-31.
- Leston, D. 1955. A key to the genera of Oncomerini Stål (Heteroptera: Pentatomidae, Tessaratominae) with the description of a new genus and species from Australia and new synonymy. Proc. R. Entomol. Soc. Lond. (B) 24(3-4):62-68.
- Piran, A. A. 1971. La Subfamilia Tessaratominae (Hemiptera-Heteroptera) en la region Neotropical. Act. Zool. Lill. 26(13):196-208.
- Polhill, R. M. 1986. Advances in Legume Systematics. Royal Botanical Gardens Kew. 200-214.
- Polhill, R. M. and R. H. Raven. 1981. Advances in Legume Systematics. Royal Botanical Gardens Kew. 245-285, 489-499, 951-977.
- Rolston, L. H. and F. J. D. McDonald. 1979. Keys and diagnoses for the families of Western

- Hemisphere Pentatomoidea, Subfamilies of Pentatomidae and tribes of Pentatominae (Hemiptera). J. N. Y. Entomol. Soc. 87(3):189–207.
- Rudd, V. E. 1969. A synopsis of the genus *Piscidia* (Leguminosae). Phytologia 18(8):473–499.
- Stål, C. 1870. Enumeratio Hemipterorum. K. Svenska. Vetensk. Akad. Handl. 9(1):63–65.

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**ARRHOPALITES DIVERSUS MILLS, 1934 (COLLEMBOLA,
ARRHOPALITIDAE): LECTOTYPE DESIGNATION AND
REDESCRIPTION OF THE COTYPES**

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Abstract.—*Arrhopalites diversus* (Mills, 1934) lectotype is assigned from the original cotypes.

Key words: Collembola, Arrhopalitidae, *Arrhopalites*.

Several authors have faced the problem of identifying of *Arrhopalites diversus* Mills, (1934) since its original description (Stach, 1945; Christiansen, 1966; Scott and Yosii, 1972; Christiansen and Bellinger, 1998). Confusion has been added as a result of misidentification by different authors (see Christiansen and Bellinger, 1998). I redefine and illustrate herein the original material designated as cotypes by Mills (1934), deposited in the Illinois State Natural History Survey, Urbana, Illinois. A lectotype is designated.

DESCRIPTION

Arrhopalites diversus (Mills, 1934)

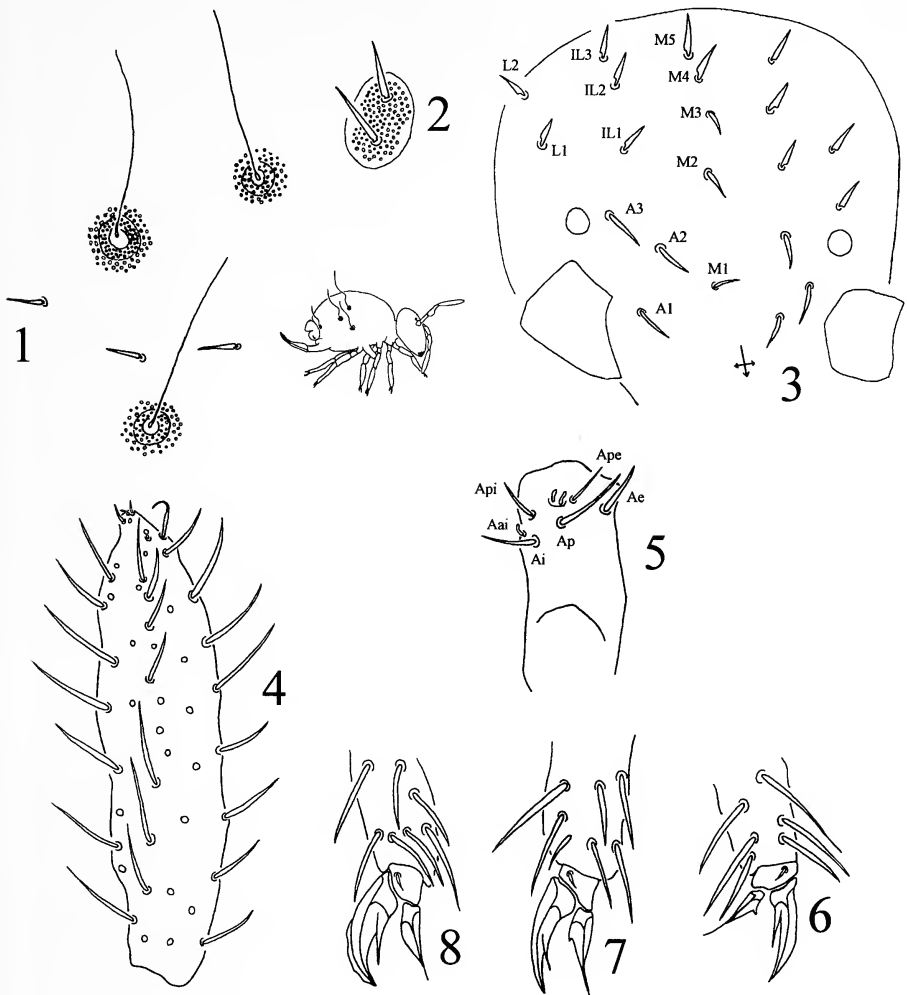
Figures 1–13

Pseudarrhopalites diversus Stach, 1945.

Description. Anterior part of body sparsely covered by short acuminate setae (Fig. 1), posterior abdominal setae in adult females 1.5 times longer than anterior ones and somewhat spinelike (Fig. 2). Eyes 1 + 1. Posterior cephalic setae A_1 , A_2 and A_3 , as well as M_1 , M_2 and M_3 not spinelike; L and IL series weakly spinelike (Fig. 3). Antennae about 1.3 times longer than cephalic diagonal. Fourth antennal segment not subdivided, longest setae less than 1.5 times diameter of segment, hook-like seta and club-shaped sensilla present at apex of segment (Fig. 4). Aai seta of apical organ of Ant. III short, blunt, and rod like; Ai , Ap and Ae similar and acuminate; Api and Ape shorter, slender, and acuminate; Ant. III swollen basally (Fig. 5).

Fore and hind unguis with a striking long filamentous inner tooth (Figs. 6–8), third unguis with a weak tunica. First unguiculus slender, with a distinct corner tooth and a short apical filament not exceeding unguis tip (Fig. 6). Second unguiculus with a little corner tooth and with very short apical filament (Fig. 7). Third unguiculus without corner tooth (Fig. 8). Metatrochanteral organ typical for the genus (Fig. 9). Tenaculum with one setula on the corpus, ramus with three teeth and a basal peglike appendage (Fig. 10).

Dens with 3:2:1:1 ventral setae; dorsal setae E_1 , E_2 and E_3 spinelike, E_4 and E_5 present. L_1 somewhat spinelike, L_2 present, L_3 absent. D_1 , D_2 Id_3 and Id_4 present

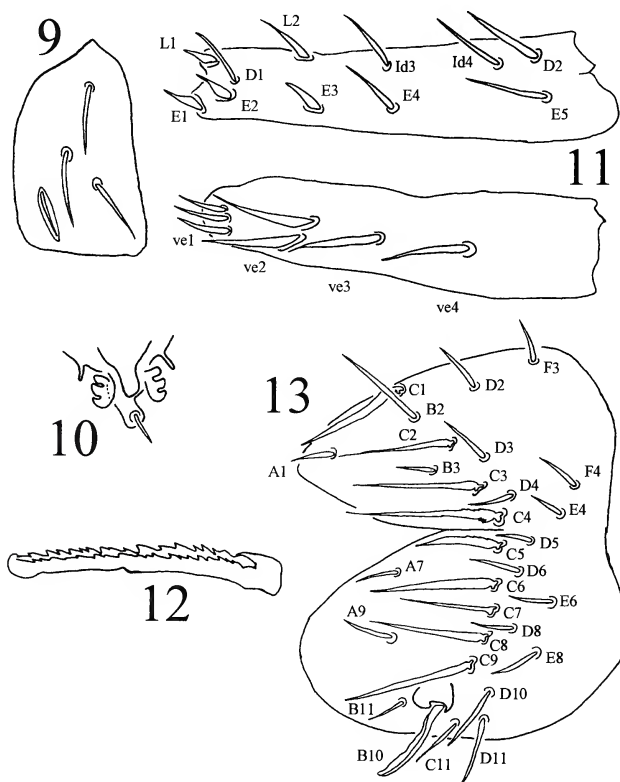


Figs. 1–8. *Arrhopalites diversus*, structural details. 1. Anterior body setae and trichobothrial pattern. 2. Posterior body setae. 3. Posterior cephalic chaetotaxy. 4. Fourth antennal segment. 5. Apical organ of third antennal segment. 6. First foot complex. 7. Second foot complex. 8. Third foot complex.

(Fig. 11). Mucro with both edges serrated, ventral lamella constricted medially (Fig. 12).

Sixth abdominal segment without spines on ventral and dorsal valves. Circumanal setae C slightly swollen basally. C₇ slender from the base to the tip, C₁₁ and D₅ present. Subanal appendage slender and flattened, leaf-like, with thinner edge slightly fringed (Fig. 13).

Type. Lectotype, ♀ (marked with an engraved ring on the underside of the slide), USA, Iowa, Leon, 31.x.1932, B. V. Travis leg., H. B. Mills det. (INHS).



Figs. 9–13. *Arrhopalites diversus*, structural details. 9. Metatrochanteral organ. 10. Tenaculum. 11. Dental chaetotaxy, dorsal and ventral view. 12. Mucro. 13. Anal valve chaetotaxy.

Material examined. USA, Iowa: 2 ♀♀, in the same slide with the lectotype (not marked with a ring); 1 ♂, Leon, 31.x.1932, B. V. Travis leg., H. B. Mills, det. (INHS); 1 ♂, Leon, 10.x.1933, B. V. Travis leg. H. B. Mills det., (INHS).

Discussion. *Arrhopalites diversus* can be easily recognized by its long filamentous inner teeth on the unguis and the slender, flattened subanal appendage. The undivided fourth antennal segment is not a good feature to identify the species, because several closely related undescribed species from Alaska, Canada, Spain and Mexico present this condition.

A more difficult problem of interpretation concerns seta D_5 . This seta is often located between C_5 and the upper-lower valve fold. It is present in the lectotype and paralectotype (Fig. 13), but it is absent in other related species studied in a complete revision of the “*A. diversus*-like” complex (in preparation).

The anal valve chaetotaxy used here follows the Lawrence’s (1978) system. However, establishing homology of the anal valve setae is always problematic (Christiansen and Bellinger, 1996), which is also true for the apical organ of the third antennal segment for which I followed Nayrolles (1991) and the cephalic and dental chaetotaxy (Christiansen and Bellinger, 1998).

This species seems to belong in the *A. caecus* group of the genus (Christiansen, 1966; Zeppelini, 1996), as shown by the presence of a medially constricted mucronal lamella and the spoon shaped mucronal apex. Christiansen (1966) points out: "It is a part of the *A. caecus* group . . . the presence of small spines on the anal valve, the presence of two ve_3 setae, and the presence of a ve_5 (seta on dens)". These features were not seen in the original type material or in the specimens of related species I studied. This indicates that a precise understanding of the phylogenetic position of the species must await the development of a detailed cladistic analysis of *Arrhopalites*.

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LITERATURE CITED

- Christiansen, K. 1966. The genus *Arrhopalites* (Collembola: Sminthuridae) in the United States and Canada. *International Journal of Speleology* 2:43–73.
- Christiansen, K. and P. Bellinger. 1996. Cave *Arrhopalites*: new to science. *Journal of Cave and Karst Studies* 58(3):168–180.
- Christiansen, K. and P. Bellinger. 1998. The Collembola of North America: North of the Rio Grande. Collegiate Press, Ames, Iowa. Vol. 4. 1095–1112.
- Lawrence, P. N. 1978. The terminology of terminalia and cartography of chaetotaxy in Collembola, its evolutionary significance and systematic utility. 1st Internat. Sem. Apterygota, Siena: 69–80.
- Mills, H. 1934. A monograph of the Collembola of Iowa. Collegiate Press, Ames, Iowa, 143 pp.
- Nayrolles, P. 1991. Chétotaxie antennaire des collembolés symphyléones. *Trav. Lab. Ecobiol. Arth. Édaph.* Toulouse 6(3):1–94.
- Scott, D. B. and R. Yosii. 1972. Notes on some Collembola of the Pacific Coast of North America. *Contr. Biol. Lab. Kyoto Univ.* 23(3/4):101–114.
- Stach, J. 1945. The species of the genus *Arrhopalites* (Börn) occurring in European caves. *Pr. Muz. Przyr.*, Krakow 1:1–47.
- Zeppelini, D. F. 1996. Estudio evolutivo de los *Arrhopalites* (Collembola) cavernícolas del Nuevo Mundo. Master degree thesis. UNAM, Mexico City, Mexico.

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**CASTE DIFFERENCES AND RELATED BIONOMIC ASPECTS OF
CHARTERGELLUS COMMUNIS, A NEOTROPICAL
SWARM-FOUNDING POLISTINE WASP
(HYMENOPTERA: VESPIDAE: POLISTINAE: EPIPONINI)**

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Abstract.—Five colonies of *Chartergellus communis*, a Neotropical swarm-founding social wasp, were analyzed in order to determine morphological differences between queens and workers. Although castes could be differentiated by color patterns, morphological differences were practically absent in three out of the five colonies. In the two other colonies, we found queens smaller than workers in all the five measured characters in one colony while in the other queens were larger than workers in the same five characters. The importance of such caste variation according to colony is discussed. Colonies contained a large variety of individuals with different kinds of ovarian development, including intermediates between queens and workers. The occurrence of such intermediate females and their role in different wasp taxa is discussed.

Key words: Polistinae, Epiponini, *Chartergellus communis*, caste differences, colonial cycle, wasp productivity.

Social organization in the Epiponini (Carpenter, 1993) is poorly known, which certainly reflects the complex bionomic characteristics of this Neotropical tribe of social wasps. Von Ihering (1903, 1904) and Ducke (1910) documented the polygynous organization of their societies and reproduction by swarming. West-Eberhard (1973, 1978), however, showed that polygyny is not universal because *Metapolybia aztecoides* alternates from polygyny to oligogyny and, eventually, monogyny in the course of its colony cycle. Such a cycle may explain monogynic records in other epiponine wasp species (Richards, 1978; West-Eberhard, 1973). This cyclical oligogyny (West-Eberhard, 1978) seems to be important in the maintenance of high genetic relatedness found in the Epiponini (Queller et al., 1988, 1993; Hughes et al., 1993).

Recent studies on *Parachartergus colobopterus* (Strassmann et al., 1998) demonstrated that the production of new queens occurs when colonies are 9–12 months old. In this species, however, the production of new swarms is concentrated in the rainy season (Strassmann et al., 1997), which clearly shows that this event is dependent on ecological factors. Nonetheless, the tropical environment in which the Epiponini thrive has rendered colony-cycles much more plastic (asynchronous) than those in the temperate climates (synchronous). The onset of nest foundation, for instance, which is limited to the beginning of the favorable season in the temperate zone species, shows a wide distributional pattern in the Neotropics spanning several months and seasons, excepting only the harshest part of the winter-dry period. Asyn-

chronous nest founding has been demonstrated in *Protopolybia acutiscutis* (Nau-
mann, 1970), *Protopolybia exigua exigua* (Simões et al., 1996) and *Polybia paulista*
(Simões and Mechi, 1983).

Another important aspect of epiponine biology is the frequent presence of ovary-
developed but uninseminated females in the colonies of several species (Richards
and Richards, 1951). These individuals were called intermediates, and Richards
(1971) assumed that their role is the production of either trophic eggs or males.

In epiponines, queens generally tend to be larger than workers as in *Protonectar-
ina silveirae* (Shima et al., 1996b), but the most conspicuous size and color differ-
ences among epiponine wasps have been found in some *Agelaia* spp. such as *A.
flavipennis* (Evans and West-Eberhard, 1970), *A. areata* (Jeanne and Fagen, 1974),
and *A. vicina* (Sakagami et al., 1996; Baio et al., 1998). In *Pseudopolybia vespiceps*,
caste differences are slight and intermediates are present (Shima et al., 1998). In
Parachartegus fraternus, differences are very slight or undetectable externally, and
so queens are not obviously different from workers and intermediates (Richards,
1978). However, in some groups, queens are significantly smaller than workers in
some characters and larger in others (Richards 1971, 1978; Shima et al., 1994).
According to Jeanne et al. (1995), who studied *Apoica pallens*, this is explained by
non-size-based differences in allometry attributed to reprogramming of larval growth
parameters in queens versus workers (Wheeler, 1991; see also O'Donnell, 1998).
Such a pattern is apparently quite common in Epiponini wasps, as it was detected
also in *Epipona guerini* (Hunt et al., 1996), *Pseudopolybia difficilis* (Jeanne, 1996),
Apoica flavissima (Shima et al., 1994), *Polybia dimidiata* (Shima et al., 1996a) and
Agelaia vicina (Baio et al., 1998). The purpose of the present paper is to analyze
the colony composition and caste differences of *Chartergellus communis*.

MATERIAL AND METHODS

Five colonies of *Chartergellus communis* were collected by spraying ether on the
nest very early in the morning. Preferences were given to colonies at certain devel-
opmental stages defined as (1) pre-emergence of workers, (2) emergence of workers
and (3) male producing, and at different months: Colony I (02/02/1995), colony II
(03/11/1995) and colony III (20/01/1996) were collected in Pedregulho, São Paulo
State, SE Brazil (20°09'S–047°37'W); colony IV (01/04/96) and colony V (02/04/
96) were collected in Nova Xavantina, Mato Grosso State, CW Brazil (14°32'S–
052°26'W). The adults were put in Dietrich's fixative for 72 h and thereafter kept in
70% ethanol. The combs were separated and the number of cells and the presence
of immatures were counted. Productivity was estimated by counting of meconial
wastes found in some cells.

In order to detect caste differences the following five external body parts were
manually measured in each female: head width (HW), alitrunk length (AL), width
of mesoscutum (MSW), basal width of tergum II (T2BW) and partial length of
forewing (WL) (see Fig. 1 in Shima et al., 1994 for more details). One hundred
individuals were chosen randomly (except for colony II of which the whole popu-
lation was measured): Later, all queens were found and measured. In that way, we
measured 142 individuals in colony I, 20 individuals in colony II, 101 individuals
in colony III, 100 individuals in Colony IV and 102 individuals in colony V. In

addition, color patterns and other morphological characteristics were examined in 25 queens, 50 workers and 3 intermediates.

We examined ovarian condition by dissecting all individuals under a stereomicroscope. In order to analyze insemination, the spermatheca was removed and put on a slide in a 1:1 solution of glycerin and alcohol (70%). The presence of sperm cells was detected by using a microscope.

Statistical analyses were performed using SAS Program Package for PC computers. Queen-worker difference for each variable was tested by Bonferroni *t*-tests after One-way Anova analyses. Stepwise discriminant analysis was used to identify the most significant contributors to caste difference. Later, the most discriminant character was used as the independent variable for size-adjusted caste contrasts, dividing the other variables to yield the relative variables. Analysis of covariance was used to test for homogeneity of slopes in queen vs. worker contrasts for those variables found to differ significantly by the stepwise discriminant analysis. Squared Mahalanobis distances (D^2) were used as an indicator of changes between casts in the different colonies analyzed. Two measured characters, which could better discriminate among different females in most of the analyzed colonies, were selected and employed in Fig. 3 for caste discrimination.

RESULTS

Nest site—According to Richards (1978), *Chartergellus communis* inhabits preferentially areas of cerrado and cerradão. The nests collected for this study were found in the following localities: Nests I, II and III were in open areas close to pasture fields and cerradão, nest IV in a urbanized area close to cerrado, and nest V in an orchard. This species shows plasticity of nest substratum. Nest I was collected in a trunk of *Eucalyptus* sp. 2.20 m high; nest II was fastened in a trunk of *Acrocomia aculeata*, 4 m high; nest III was located in the door of a wood hut, 2 m high; nest IV located in a branch of *Mangifera indica*, 2.50 m high, and nest V was fastened in an elevated water tank, 3.40 m high. In the municipal district of Pedregulho, São Paulo State SP, nests ($N = 3$) of *C. communis* were observed built on storerooms and directly on rocks in a ravine and in Bonito, Mato Grosso do Sul State, on a wooden post fence ($N = 2$), (S. Mateus, pers. obs.).

Nest architecture, colony composition and colony phase. The envelope is of predominantly gray coloration and is made with long vegetable fibers. The construction lines are parallel, giving a grooved aspect to the surface. In the upper part of the envelope (Fig. 1A), an area composed of thicker vegetable fibers strongly stuck to each other and to the substratum with salivary substance gives to that area a spongy aspect (five paper pillars or floss between substrate and envelope margin, particularly on the inside of the upper region, as described by Wenzel, 1998). The entrance of the nest is located in the lower part of the envelope (Fig. 1C), and measured 1 cm in diameter on the average, with a border in a ring form measuring 4 mm height on the average. The internal part of the envelope is entirely impregnated with glossy material of glandular origin. The envelope is very well camouflaged, giving great protection against the attack of some predators. The coloration of the envelope is always very similar to the substratum. Accompanying the grooves there are non-fibrous vegetable materials in a variety of colors such as vegetable coal (black) and

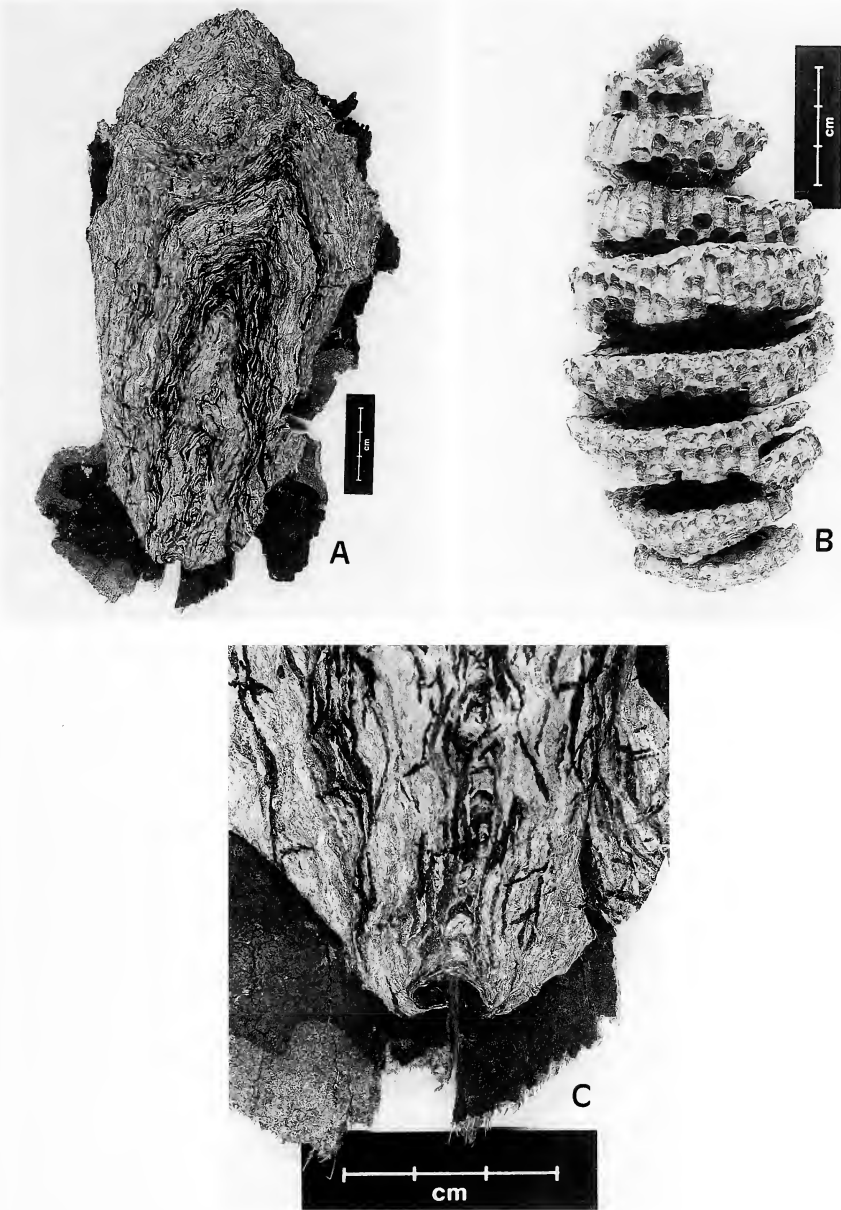


Fig. 1. Nest of *Chartergellus communis*. A—Envelope; B—Combs and C—Nest entrance.

Table 1. Immatures number, combs number, maximum number of meconia found in one cell and ovary development types found in the five analyzed colonies of *Chartergellus communis*.

Colony number	Eggs	Larvae	Pupae	Combs	Meconia	Males	Ovary development types				
							1	2	3	4	5
1	161 (32%)	147 (29%)	196 (39%)	8	3	3	139 (49%)	70 (24%)	14 (5%)	2 (1%)	61 (21%)
2	52 (43%)	52 (43%)	17 (14%)	2	2	0	17 (85%)	1 (5%)	0	0	2 (10%)
3	281 (100%)	0	0	3	0	0	170 (78%)	28 (13%)	12 (6%)	0	8 (3%)
4	168 (33%)	121 (24%)	221 (43%)	6	4	0	115 (54%)	80 (38%)	9 (4%)	0	8 (4%)
5	343 (56%)	207 (34%)	61 (10%)	8	5	0	192 (32%)	356 (60%)	41 (7%)	1 (0.2%)	3 (0.8%)

peels of bark (dark-brown and light-brown) that are incorporated into the envelope with salivary substance. The combs are built of the same material as the envelope (Fig. 1B). They are gray in color, being fastened to the substratum by a marginal peduncle. In combs with a high number of cells more than one peduncle was found. Typical peduncles are 2 cm in height and 1 cm in width, are composed of long vegetable fibers, and are strongly stuck to the substratum by salivary secretion. Combs at the beginning of construction have a small base, and it increases progressively with the construction of new cells. In older combs the peduncle measures 5 cm on length on the average for 4 cm height and 2 cm width. The combs generally have an elliptical form. Cells face down, with simple parallel hexagonal walls; the diameter is 4 mm on average, and the height of a cell with a pupa in it is 11 mm on average. Cells may be lengthened after adult emergence due to accumulation of meconium layers.

Nest composition in the five analyzed colonies is detailed in Table 1. Nest I had 8 combs with 764 cells; nest II had two small combs with 124 cells; nest III had 3 new combs with 284 cells; nest IV had 6 combs with 761 cells; and nest V had 8 combs with 1,342 cells.

After checking colony and nest composition, we could determine which colonies were in the specific colony phases: 1—*Pre-emergence of workers phase*: colony 3; 2—*Emergence of workers phase*: colonies 2, 4 and 5; 3—*Males producing phase*: colony 1.

Productivity—In nest I all combs were examined (N = 8). Two hundred seventy eight cells had one meconium; these were located in the periphery of the combs. One hundred sixty cells had two meconia and were located more inside the combs, and in 44 cells located close to the peduncle three meconia were found. These results suggest that about 730 individuals were produced. In nest II there were 43 cells with one meconium and 9 cells with two, thus, 61 individuals were produced. Nest III was of recent foundation and no meconium was found. In nest IV productivity was evaluated in two combs. The largest had 180 cells; of these, 30 contained one meconium, 82 had two meconia, 50 had three meconia and 17 cells had 4 meconia; for

a total productivity from this comb of about 412 individuals. The other analyzed comb contained 76 cells; in 35 one meconium was found; 28 had two meconia, so that in this comb 91 individuals were produced. In nest V, one comb with 256 cells was used to evaluate the productivity. It had 67 cells with one meconium, 57 cells with two, 63 cells with three, 53 cells with four, and 16 cells with 5 (662 individuals were produced in this comb).

Ovarian development—From colony I, 286 females and 3 males were collected (Table 1). After ovary dissection females were classified as: 139 with ovary without development (Fig. 2, pattern 1), 70 with beginning of oocyte formation (Fig. 2, pattern 2), 14 with small well defined oocytes (Fig. 2, pattern 3), 2 females with big oocytes ready for oviposition located in the base of ovary (Fig. 2, pattern 4), and 61 with well-developed oocytes (Fig. 2, pattern 5). Only 54 out of 61 females from pattern 5 were inseminated. In colony II, females were classified (Table 1) as: 17 with pattern 1, 1 with pattern 2 and 2 inseminated females with pattern 5. Colony III (Table 1) had 170 females with pattern 1, 28 females with pattern 2, 12 females with pattern 3, and 8 inseminated females with pattern 5. Colony IV (Table 1) had 115 females with pattern 1, 80 females with pattern 2, 9 females with pattern 3, and 8 inseminated females with pattern 5. Colony V (Table 1) had 192 females with pattern 1, 356 with pattern 2, 41 with pattern 3, 1 female had pattern 4, and 3 inseminated females had the pattern 5.

Caste and color pattern differences—Difference was observed between queens and workers (including those with various degrees of ovary development, see above) in the areas of light coloration: in the gena with a wide streak, touching eye and reaching the ventral margins from top of eye to near mandibles, along the whole length of pronotal keel, the hind margin of pronotum narrowly, the dorsal half of metanotum, and a small posterior corner of mesoscutum. In the workers the marks are strong yellow, while in the queens these marks are light yellow to near white. The gastral sterna in queens are light brown, while in workers they are dark brown. The mandibles were red at the basal half in queens, while in workers they are dark red.

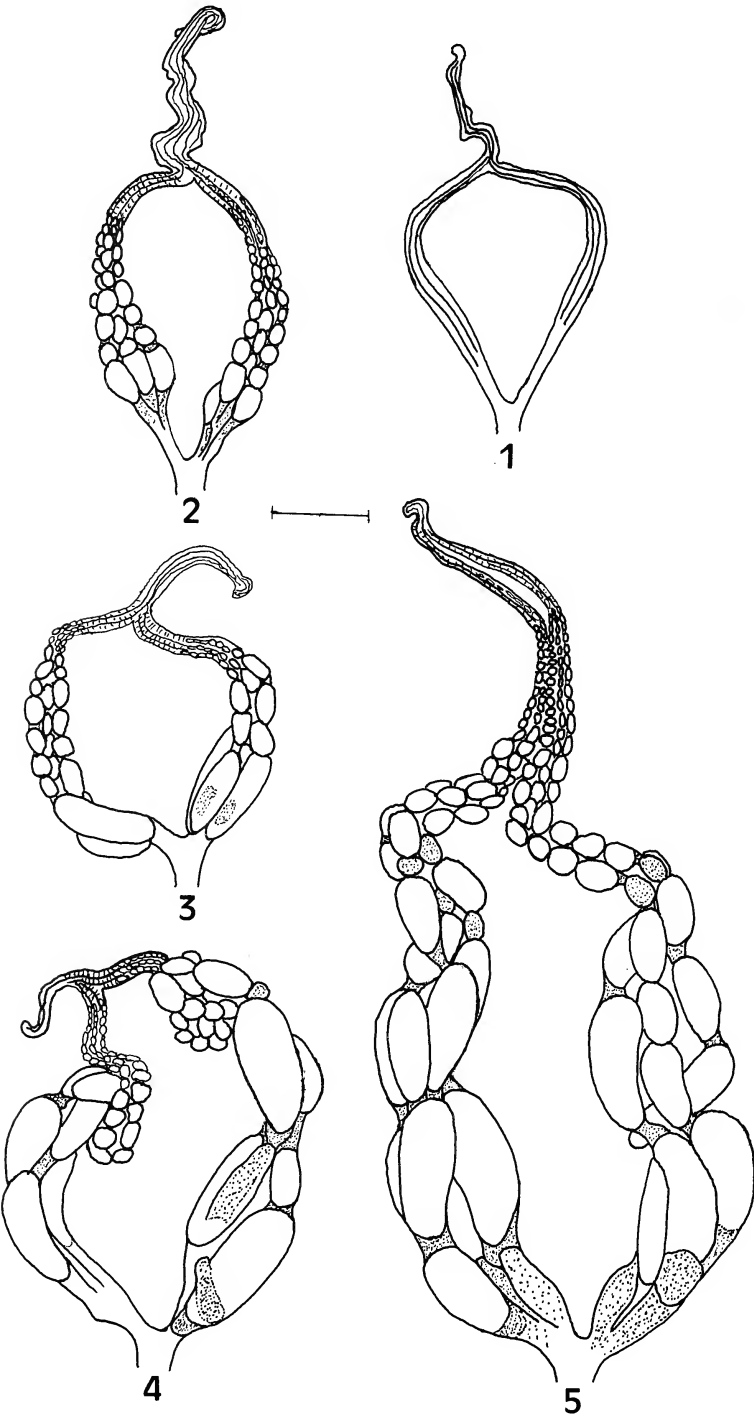
Morphometric analyses

Because such color attributes were efficient to separate between queens and workers (see above), they were used in association with insemination in order to determine groups for multivariate analyses. In the following analyses, queens were the individuals that presented insemination and specific color patterns while workers were determined by non-insemination and color patterns. In this way, we included intermediate females in the worker group.

Colony I

Among the relationships of the averages of the five analyzed characters in queens and workers (Table 2), statistically significant differences between castes were found in all analyzed characters. The significance test (*t*-test, $P < 0.05$) showed that queens are slightly smaller than workers in colony I of *C. communis* (Fig. 3.1).

The results of the stepwise discriminant analysis based on the nine characters also showed that the most contributing characters were: HW, MSW and T_2BW . The great contribution to total variance was due to MSW. In accordance with multivariate



analyses of other social wasps (Jeanne et al., 1995; Jeanne, 1996; Hunt et al., 1996) we used MSW as an independent variable for size-adjusted contrasts because it appeared as one of the greatest factors contributing to total variance between castes in the three analyzed species (see above). Each of the four other characters was divided by MSW to yield four new, relative variables. The following greatest factors were found after stepwise discriminant analyses: HW, AL and T_2BW (Table 2). These variables were independently analyzed using covariance analyses. Queens and workers significantly differ in slope only in T_2BW ($F = 1395.2$, $P \leq 0.0001$).

Generalized Mahalanobis distance (D^2 : Anderson, 1968) was statistically significant ($D^2 = 2.65$; $F = 16.32$, $P < 0.0001$) indicating slight but significant differences between the castes. In fact, comparisons between predicted and observed classifications showed that workers were 88.37% correctly classified by the method and queens were 66.07% correctly classified.

Colony II

Among the relationships of the averages of the five analyzed characters in queens and workers (Table 3), statistically significant differences between queens and workers were found in all analyzed characters. The test (t -test, $P < 0.05$) showed that queens are larger than workers in all five analyzed characters in the colony II of *C. communis* (Fig. 3.2).

Results of the stepwise discriminant analysis based on the five characters also showed that the greatest factors were: MSW, AL and WL. The largest contribution to total variance was due to WL. Using WL as an independent variable for size-adjusted contrasts isolated AL after stepwise discriminant analyses (Table 3). These variables were independently analyzed using covariance analyses. Queens and workers differed significantly in slope in MSW ($F = 13.08$, $P = 0.02$), AL ($F = 8.74$, $P = 0.009$) and T^2BW ($F = 11.59$, $P = 0.003$).

Generalized Mahalanobis distance (D^2 : Anderson, 1968) was statistically significant ($D^2 = 49.67$; $F = 9.68$, $P = 0.0004$) indicating significant differences between the castes. In fact, comparisons between predicted and observed classifications showed that workers were 100% correctly classified by the method and queens were 100% correctly classified.

Colony III

There were no statistically significant differences between queens and workers in any analyzed character (t -test, $P < 0.05$) (Table 4), in colony III of *C. communis* (Fig. 3.3).

Results of the stepwise discriminant analysis based on the five characters also showed no difference between the castes. Using the forward procedure for stepwise

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Fig. 2. Grades of ovarian development in *Chartergellus communis*. 1—ovaries without development, 2—ovaries with beginning of oocyte formation, 3—ovaries with small well defined oocytes, 4—ovaries with big oocytes ready for oviposition located in the base of the ovary; 5—ovaries with well-developed oocytes.

Table 2. Morphometric caste differences in *Chartergellus communis* (Colony I).

Characters	Means \pm SD		<i>t</i> -test	Stepwise discriminant analyses			
				Contributor variables	F	T ₂ BW as the independent variable	
	Queens (N = 56)	Workers (N = 86)				Contributor variables	F
HW	3.607 \pm 0.075	3.663 \pm 0.073	4.4*	X	4.30***	X	9.50**
MSW	2.980 \pm 0.086	3.055 \pm 0.099	4.6*	X	23.07*	X	3.00#
AL	4.943 \pm 0.191	5.166 \pm 0.180	7.0*				
T ₂ BW	3.128 \pm 0.083	3.209 \pm 0.092	5.3*	X	4.42***	X	2.61#
WL	4.324 \pm 0.133	4.428 \pm 0.117	4.9*				

P* < 0.001, *P* < 0.02, ****P* < 0.05, # not significant (*P* > 0.05).

discriminant analysis for castes as the group variable, any variable was included in the model, indicating that any character employed would explain the variation equally well.

Colony IV

Among the relationships of the averages of the five analyzed characters in queens and workers (Table 5), only wing length (WL) was statistically smaller in queens in colony IV of *C. communis* (Fig. 3.4).

Results of the stepwise discriminant analysis based on the five characters also showed that the greatest factors were: MSW, AL and WL. The great contribution to total variance was due to WL. Using WL as an independent variable for size-adjusted contrasts the following factors were found after stepwise discriminant analyses: MSW, AL and WL (Table 5). These variables were independently analyzed using covariance analyses. Queens and workers differed significantly in slope in MSW (*F* = 10.31, *P* = 0.002), and AL (*F* = 4.15, *P* = 0.04).

Generalized Mahalanobis distance (*D*²: Anderson, 1968) was statistically significant (*D*² = 2.85; *F* = 6.06, *P* = 0.008) indicating slight but significant differences between the castes. In fact, comparisons between predicted and observed classifications showed that workers were 97.83% correctly classified by the method and queens were 50% correctly classified.

Colony V

Among the relationships of the averages of the five analyzed characters in queens and workers (Table 6), there were no statistically significant differences between queens and workers (*t*-test, *P* < 0.05) in colony V of *C. communis* (Fig. 3.5).

Results of the stepwise discriminant analysis based on the five characters also showed absence of differences between the castes. Using the forward procedure for stepwise discriminant analysis using castes as the grouping variable, any variable was included in the model, indicating that any character employed would explain the variation equally well.

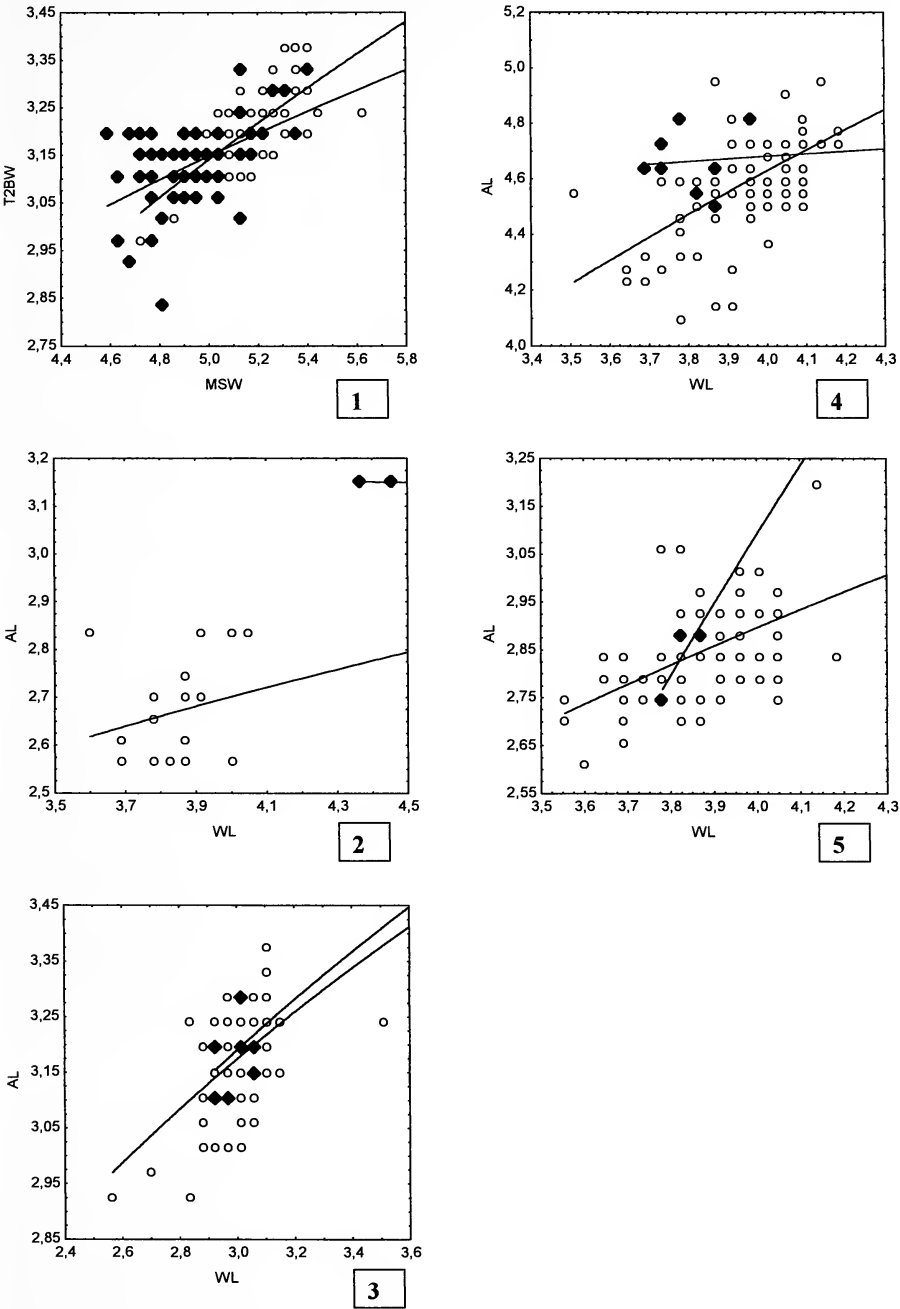


Fig. 3. Discrimination between queens and workers of *Chartergellus communis* in colonies 1, 2, 3, 4 and 5 respectively, based on the two most discriminant characters. Black diamonds = queens, white circles = workers.

Table 3. Morphometric caste differences in *Chartergellus communis* (Colony II).

Characters	Means \pm SD		<i>t</i> -test	Stepwise discriminant analyses			
				Contributor variables	F	WL as the independent variable	
	Queens (N = 2)	Workers (N = 18)				Contributor variables	F
HW	3.645 \pm 0.001	3.322 \pm 0.088	5.1*				
MSW	3.150 \pm 0.000	2.670 \pm 0.107	6.2*	X	1.23#		
AL	5.063 \pm 0.032	4.282 \pm 0.195	5.5*	X	2.22#		
T ₂ BW	3.442 \pm 0.032	2.887 \pm 0.150	5.1*				
WL	4.410 \pm 0.064	3.845 \pm 0.116	6.7*	X	7.85#	X	1.32#

P* < 0.001, *P* < 0.02, ****P* < 0.05, # not significant (*P* > 0.05).

DISCUSSION

Chartergellus communis presented, in most cases, incipient differentiation among queens and workers, which is similar to that observed in *Pseudopolybia vespiceps* (Shima et al., 1998) and *Parachartergus smithii* (Mateus et al., 1997). Queen-worker dimorphism was practically absent among studied females, excepting the queen-worker dimorphism found in colonies I and II (Fig. 3). However, the most intriguing characteristic is that in the former, queens were smaller in all five analysed morphological characters while in the latter, queens were larger than workers. Besides, castes can be determined in the two colonies by single-variable contrasts, in most colonies the overlap between castes was sufficient to mask multivariate discrimination. However, color differences were good enough to differentiate between queens and workers. In addition, in colonies for which stepwise discriminant analysis showed differences between the castes, the slopes between castes were different in some of the variables. The combination of color and slope differences between the castes suggests that the pattern of differences found in the analyzed colonies could be an expression of a reprogramming of growth parameters during larval growth (Jeanne et al., 1974; Jeanne, 1996; Hunt et al., 1996).

The study of morphological differences in female wasps, collected in different stages of the colonial life cycle, in *Polybia occidentalis*, *P. paulista* and *P. scutellaris* (Noll and Zucchi, in press.) showed that caste differences progressively increase because smaller queens disappear earlier than larger ones. It was suggested that this

Table 4. Morphometric caste differences in *Chartergellus communis* (Colony III).

Characters	Means \pm SD		<i>t</i> -test	Stepwise discriminant analyses	
	Queens (N = 8)	Workers (N = 93)		Contributor variables	F
HW	3.617 \pm 0.041	3.618 \pm 0.065	0.06#		
MSW	2.998 \pm 0.053	3.006 \pm 0.106	0.20#	No variable was included in the model.	
AL	4.928 \pm 0.125	4.875 \pm 0.172	-0.84#		
T ₂ BW	3.189 \pm 0.070	3.176 \pm 0.087	-0.42#		
WL	4.224 \pm 0.074	4.237 \pm 0.126	0.28#		

Not significant (*P* > 0.05).

Table 5. Morphometric caste differences in *Chartergellus communis* (Colony IV).

Characters	Means \pm SD		t-test	Stepwise discriminant analyses			
				Contributor variables	F	WL as the independent variable	
	Queens (N = 8)	Workers (N = 92)				Contributor variables	F
HS	3.487 \pm 0.042	3.511 \pm 0.076	0.88#				
MSW	2.914 \pm 0.047	2.910 \pm 0.090	-0.12#	X		X	
AL	4.663 \pm 0.115	4.580 \pm 0.179	-1.28#	X	6.94**	X	
T ₂ BW	2.970 \pm 0.132	2.964 \pm 0.118	-0.20#		1.06#		8.25**
WL	3.808 \pm 0.090	3.939 \pm 0.127	2.84#	X	17.76#		2.29#

P* < 0.001, *P* < 0.02, ****P* < 0.05, # not significant (*P* > 0.05).

mechanism can be of selective importance in the onset of the cyclical oligogyny, which is well-documented in many swarm-founding polistines. Ovary-developed, unseminated females (intermediates) and males only occurred at later stages of colony developmental cycles.

Comparing the different groups of queens and workers collected in differently aged colonies in *C. communis*, we observed a pattern more complex than that mentioned above in some *Polybia*. In two colonies in apparently later stages of colony development (colonies I and II, in male producing and emergence of workers phase, respectively), single variable statistics detected caste differences. In other colony in pre-emergence phase (colony IV), differences between castes were found in wing length (WL).

Our observations suggest some possibilities. First, sampling made in this work was not able to determine the same pattern of queen selection observed in previous species. Secondly, the pattern found in some *Polybia* (Noll and Zucchi, in press.) could depend on prerequisites, such as a minimum level of caste differentiation, upon which selective events could operate. In that case, the mentioned mechanism would not be applied to *C. communis*. In fact, this seems reasonable because, unlike some *Polybia* (Noll et al., 1997; Noll and Zucchi, submit.) that showed both differences in size and shape, *C. communis* does present mainly differences in shape and color between castes. In this case, queens' size would not affect their fitness during the colony cycle. Thus, there maybe at least two different schemes of queen selection

Table 6. Morphometric caste differences in *Chartergellus communis* (Colony V).

Characters	Means \pm SD		t-test	Stepwise discriminant analyses	
	Queens (N = 3)	Workers (N = 87)		Contributor variables	F
HW	3.435 \pm 0.026	3.440 \pm 0.064	0.15#	No variable was included in the model.	
MSW	2.835 \pm 0.078	2.844 \pm 0.092	0.17#		
AL	4.440 \pm 0.145	4.512 \pm 0.172	0.71#		
T ₂ BW	2.925 \pm 0.045	2.889 \pm 0.103	-0.61#		
WL	3.825 \pm 0.045	3.865 \pm 0.119	0.57#		

Not significant (*P* > 0.05).

in epiponines during cyclical oligogyny: size dependent or not. In the former larger queens would preferentially survive versus smaller ones, while in the latter case the size of the queens is an independent trait.

Another explanation, previously suggested by Noll and Zucchi (in press), suggests that differences between castes found in some colonies and not in others from the same species could indicate that during the colony cycle new queens produced would be morphologically distinct from their mothers. However, such possibility needs an extensive analysis of colonies during the whole cycle.

Intermediate females were found in two colonies with different numbers of queens (21% and other 0.8% of the population, in colonies I and V, respectively). These results are different from certain species of *Polybia* in which intermediates were found especially in colonies with a low number of queens (Noll and Zucchi, in press), and in *Protopolybia exigua* (F. B. Noll, unpub.) and *Brachygastra mellifica* (Hastings et al., 1998), in which intermediates were always found. The intermediates' presence demonstrates that control of the ovarian development, possibly by the queens, is quite flexible at some stages of the colonial cycle, being more effective during oligogyny.

As stated by Richards (1978): "In many species a few or even (*Protopolybia*, *Brachygastra*, some *Polybia*) many intermediates occur with the ovarioles slightly enlarged. In other characters the intermediates are sometimes more like workers, sometimes more like queens and while their significance is uncertain it seems likely that they may have different origins, perhaps as suppressed queens or as egg-laying workers, or perhaps even, in some cases, as a stage in the development of queens." Such a characterization seems reasonable, especially because some of the possible groups were clearly observed:

1—The presence of intermediates similar to workers was observed in *Protopolybia* (Noll et al., 1996) and *Brachygastra mellifica* (Hastings et al., 1998). In these species, intermediates are found during the whole colonial cycle. In this case, queen control on workers' ovary-development seems to be highly flexible. In addition, because male production is apparently completely controlled by queens (Hastings et al., 1998), intermediates' eggs could be used for trophic purposes (Shima et al., 1998). Intermediates similar to workers were found also in some *Polybia* species (Noll and Zucchi, in press), however, in this case, intermediates appear only at the final stage of the colonial cycle, usually when only a few queens (sometimes just one queen) are present in the colony. Workers' ovary development, in this case, could reflect the loss of dominance in the colony as observed in some species of *Bombus* (Sakagami, 1976). Even though no male production analyses were performed, male production by intermediates (Richards, 1971) cannot be discarded because, in *Polybia paulista* (Noll and Zucchi, in press), a large number of males were found under oligogyny. This case differs from the results obtained in *Parachartergus colobopterus* (Strassmann et al., 1998), in which male production would occur during high queen number in order to accommodate workers interests, according to kin selection proposals.

2—The presence of queen-like intermediates or uninseminated queens was recorded in *Polybia dimidiata* (Shima et al., 1996b; Maule-Rodrigues et al., 1974); *Agelaia vicina* (Sakagami et al., 1996; Baio et al., 1998) and *Polybia occidentalis* (Noll et al., in prep.). Such intermediates can be interpreted as young queens or uninsemi-

nated queens with low reproductive potential. However, their role in social regulation in the colony remains speculative.

3—In *Pseudopolybia vespiceps* (Shima et al., 1998), *Parachartergus smithii* (Mateus et al., 1997), *P. colobopteris* (Strassmann et al., 1998) and *Chartergellus communis* (present data) caste differences are absent, either morphologically, or physiologically. In this case, all individuals could have, in some way, the possibility of reaching “reproductive status” as previously proposed by Forsyth (1978), at least in male production. In fact, that possibility cannot be discarded, because seven intermediates with queen-like ovary status were found in colony I in a male producing phase (see *Ovarian development*). In this connection, it is important to mention that peculiar life-cycle of the neotropical *Bombus atratus*, relies on two kinds of intermediate females, namely unmated (male producing), and mated females. Moreover, potential perennial traits of the colonies, exclusively depends on the latter kind of intermediates, because these can restart female’s production especially at the close of mother-queen’s reproduction period, and right after the queen’s premature death, as well (Zucchi et al., 1996).

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LITERATURE CITED

- Anderson, T. W. 1968. Introduction to multivariate statistical analysis. John Wiley and Sons Inc., New York, 374 pp.
- Baio, M. V., F. B. Noll, R. Zucchi and D. Simões. 1998. Non-allometric caste differences in *Agelaia vicina* (Hymenoptera, Vespidae, Epiponini). *Sociobiology* 34:465–476.
- Carpenter, J. M. 1993. Biogeographic patterns in the Vespidae (Hymenoptera): Two views of Africa and South America, pp. 139–155 in P. Goldblatt (ed.), *Biological Relationships between Africa and South America*. Yale University Press, New Haven.
- Ducke, A. 1910. Revision des guêpes sociales polygames d’Amérique. *Annales Musei Nationales Hungarici* 8:449–544.
- Evans, H. E. and M. J. West-Eberhard. 1970. The wasps. University Michigan Press, Ann Arbor, Michigan. vii + 265 pp.
- Forsyth, A. 1978. Studies on the behavior ecology of polygynous social wasps. Doctoral Dissertation, Harvard University, Cambridge, 226 pp.
- Hastings, M. D., D. C. Queller, F. Eischen and J. E. Strassmann. 1998. Kin selection, relatedness and worker control of reproduction in a large-colony epiponine wasp, *Brachygastra mellifica*. *Behavioral Ecology* 9:573–581.
- Hunt, J. H., D. K. Schmidt, S. S. Mulkey and M. A. Williams. 1996. Caste dimorphism in *Epipona guerini* (Hymenoptera: Vespidae): Further evidence of larval determination. *Journal of Kansas Entomological Society* 69:362–369.
- Hughes, C. R., D. C. Queller, J. A. Negrón-Sotomayor, J. E. Strassmann, C. Solis and K. R. Gastreich. 1993. The maintenance of high genetic relatedness in multi-queen colonies of social wasps. In: Keller, L. (ed.), *Queen Number and Sociality in Insects*. Oxford University Press, New York. pp. 153–170.

- Ihering, R. von. 1903. Des Vespides de l'Amérique du Sud. *Annales de la Société Entomologique de France* 72:144–155.
- Ihering, R. von. 1904. As vespas sociaes do Brasil. *Revista do Museu Paulista* 6:97–309, 5 pls., 3 figs.
- Jeanne, R. L. and R. Fagen. 1974. Polymorphism in *Stelopolybia areata* (Hymenoptera, Vespidae). *Psyche* 81:155–166.
- Jeanne, R. L., C. A. Graf and B. S. Yandell. 1995. Non-Size-Based morphological castes in a social insect. *Naturwissenschaften* 82:296–298.
- Jeanne, R. L. 1996. Non-allometric queen-worker dimorphism in *Pseudopolybia difficilis* (Hymenoptera: Vespidae). *Journal of Kansas Entomological Society* 69:370–374.
- Mateus, S., F. B. Noll and R. Zucchi. 1997. Morphological caste differences in the neotropical swarm-founding Polistine wasps: *Parachartegus smithii* (Hymenoptera: Vespidae). *Journal of New York Entomological Society* 105(3–4):129–139.
- Maule-Rodrigues, V. and B. B. Santos. 1974. Vespídeos sociais: Estudo de uma colônia de *Polybia dimidiata* (Olivier, 1791) (Hymenoptera, Polistinae). *Revista Brasileira de Entomologia* 18:37–42.
- Naumann, M. G. 1970. The nesting behavior of *Protopolybia pumila* in Panama (Hymenoptera, Vespidae). PhD. thesis, University of Kansas, Lawrence, 182 pp.
- Noll, F. B., S. Mateus and R. Zucchi. 1996. Morphological caste differences in neotropical swarm-founding polistinae wasps. V—*Protopolybia exigua exigua* (Hymenoptera: Vespidae). *Journal of New York Entomological Society* 104(1):61–68.
- Noll, F. B., S. Mateus and R. Zucchi. 1997. Morphological caste differences in the neotropical swarm-founding and polygynous polistinae wasps, *Polybia scutellaris*. *Studies on the Neotropical Fauna and Environment* 32:76–80.
- O'Donnell, S. 1998. Reproductive caste determination in eusocial wasps (Hymenoptera: Vespidae). *Annual Review of Entomology* 43:323–346.
- Queller, D. C., C. R. Hughes and J. E. Strassmann. 1998. Genetic relatedness in colonies of tropical wasps with multiple queen. *Science* 242:1155–1157.
- Queller, D. C., J. A. Negrón-Sotomayor, C. R. Hughes and J. E. Strassmann. 1993. Queen number and genetic relatedness in a neotropical wasp, *Polybia occidentalis*. *Behavioural Ecology* 4:7–13.
- Richards, O. W. 1971. The biology of the social wasps (Hymenoptera: Vespidae). *Biological Review* 46:483–528.
- Richards, O. W. 1978. The social wasps of the Americas excluding the Vespinae British Museum (Natural History), London, 580 pp.
- Richards, O. W. and M. J. Richards. 1951. Observations on the social wasps of South America. *Transaction of the Entomological Society of London* 102:1–170.
- Sakagami, S. F. 1976. Specific Differences in the Bionomic Characters of Bumblebees. A Comparative Review. *Journal of the Faculty of Science, Hokkaido University Ser. VI, Zool.* 20(3), 1976.
- Sakagami, S. F., R. Zucchi, S. Yamane, F. B. Noll and J. M. F. Camargo. 1996. Morphological caste differences in *Agelaiia vicina*, the neotropical swarm-founding polistine wasp with the largest colony size among social wasps (hymenoptera: vespidae). *Sociobiology* 28(2): 1–17.
- Shima S. N., S. Yamane and R. Zucchi. 1994. Morphological caste differences in some neotropical swarm-founding polistine wasps. I—*Apoica flavissima* (Hymenoptera, Vespidae). *Japanese Journal of Entomology* 62(4):811–822.
- Shima, S. N., S. Yamane and R. Zucchi. 1996a. Morphological caste differences in some Neotropical swarm-founding polistine wasps. II. *Polybia dimidiata* (Hymenoptera, Vespidae). *Japanese Journal of Entomology* 64(1):131–144.
- Shima, S. N., S. Yamane and R. Zucchi. 1996b. Morphological caste differences in some

- Neotropical swarm-founding polistine wasps III. *Protonectarina sylveirae* (Hymenoptera, Vespidae). Bulletin of the Faculty of Education, Ibaraki University 45:57–67.
- Shima, S. N., F. B. Noll, R. Zucchi and S. Yamane. 1998. Morphological caste differences in some Neotropical swarm-founding polistine Wasps IV. *Pseudopolybia vespiceps*, with preliminary considerations on the role of intermediate females in social organization of the Epiponini (Hymenoptera, Vespidae). Journal of Hymenoptera Research 7:280–295.
- Simões, D. and M. R. Mechi. 1983. Estudo sobre a fenologia de *Polybia (Myrapetra) paulista* IHERING, 1896 (Hymenoptera, Vespidae). Naturalia 8:185–191.
- Simões, D., F. B. Noll and R. Zucchi. 1996. Duration of *Protopolybia exigua* nest and related aspects as influenced by phorid fly infestation (Vespidae, Polistinae, Epiponini). Sociobiology 28(1):121–129.
- Strassmann, J. E., C. R. Solís, C. R. Hughes, K. R. Goodnight and D. C. Queller. 1997. Colony life history and demography of a swarm-founding social wasp. Behavioral, Ecology and Sociobiology 40:71–77.
- Strassman J. E., K. F. Goodnight, C. J. Klinger and D. C. Queller. 1998. The genetic structure of swarms and the timing of their production in the queen cycles of neotropical wasps. Molecular Ecology 7:709–718.
- Wenzel, J. W. 1998. A generic key to the nest of hornets, yellowjackets, and paper wasps worldwide (Vespidae: Vespinae, Polistinae). American Museum Novitates 3224:1–39.
- West-Eberhard, M. J. 1973. Monogyny in “polygynous” social wasps. Proc. VII Congr. IUSSI, London 396–403.
- West-Eberhard, M. J. 1978. Temporary queens in *Metapolybia* wasps: non-reproductive helpers without altruism? Science 200:441–443.
- Wheeler, D. E. 1991. The developmental basis of worker castes polymorphism in ants. American Naturalist 138:1218–1238.
- Zucchi, R., F. B. Noll, S. N. Shima and S. Mateus. 1996. Similar Trends in Hymenoptera Eusociality (Meliponinae, Bombini, Epiponini). Proceedings XX International Congress of Entomology Firenze, Italy 391.

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BOOK REVIEWS

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Psocoptères Euro-Méditerranéens. Faune de France. No. 83, xix + 517 pp., 148 text figs., 11 photo plates.—Charles Lienhard. 1998. Fédération Française des Sociétés de Sciences Naturelles. Address: Faune de France, B. P. No. 392, F-75232, Paris Cedex 05, France (price FF521/Euro 79.47 + mailing costs). ISBN 2-903052-17-4.

My colleague Charles Lienhard of the Muséum d'Histoire naturelle de Genève has produced a beautiful work on the taxonomy of the Psocoptera of the Western Palearctic Region. The volume is dedicated to the memory of the late André Badonnel, a French psocidologist who for some 60 years produced elegant studies on the Psocoptera of Europe, Africa, Madagascar, and tropical America. Indeed, the present volume was begun by Badonnel, who, at an advanced age saw the need to request the collaboration of his much younger Swiss colleague, Lienhard. Badonnel's death in 1991, after completion of only one chapter (Généralités), left to Lienhard the completion of the work. Lienhard had already begun a series of studies on particular taxa of the western Palearctic psocid fauna, involving collecting in remote parts of southern Europe, Mediterranean Africa, and the Atlantic islands (Canaries and Madeira)—areas where undescribed species were still to be found. He was, thus, in a good position to complete the project.

From the cover to the last plate, the work presents great artistry. On the cover is a color photograph of a female *Psococerastis gibbosa* (Sulzer), the largest European psocid. The last plate, covering two pages, is a series of color photographs of spermathecae and spermatophores taken with interference contrast microscopy and two females of *Lepinotus patruelis* Pearman with their intriguing capsular spermatophores showing through the abdominal cuticle.

The book is divided into a brief preface followed by a brief "Avant-propos" in which the history of the book's development is outlined. There follows a three-page "Avis aux lecteurs" in which the geographic limits of the work are described. Included are all of Europe eastward to the Ural Mountains and Caspian Sea, northern Africa (Morocco, Algeria, Tunisia, Libya, and Egypt), the Near East and the Middle East (Jordan, Israel, Lebanon, Syria, and Turkey), and the Atlantic archipelagoes of Madeira and the Canaries. A total of 244 species of Psocoptera in 65 genera are recorded from the region. In this section the nature and use of the keys, and the treatment of species in the text is discussed. The "avis" is followed by a single-page list of taxonomic changes proposed in the book: new synonymies, new combinations, lectotype designations, etc.

The first chapter or division of the text proper, "Généralités", opens with a brief introduction to the psocids, followed by an equally brief account of the historical development of our knowledge of the group. A graph of the cumulative number of named species through time indicates that the number nearly quadrupled in the fifty

years between the publication by Roesler (1944) and that of Lienhard (1994). At the latter time, the number of species in the world fauna stood at 3,860 and showed no sign of leveling off. I estimate that the number now stands (1999) at about 4,200 and still shows no sign of leveling off. It is a far cry from Steyskal's (1973) prediction that the number would level at about 2,000 species! Adult morphology is reviewed in detail, along with standard procedures for measurement. No attempt is made to deal with identification of larvae, and so they are treated very briefly on three pages. There is an extensive (24 pp.) review of biology and ecology. The section on parthenogenesis, of much interest to this reviewer, seems to be as complete as the current literature allows. There is a compactly-written review of the phylogeny of the group of orders usually called Hemipteroids by North American authors, here called Acercaria, following Hennig (1969, 1981). The Psocoptera are viewed as the sister group of the Phthiraptera. The two groups, constituting a superorder Psocodea, form a sister group with Superorder Condylgnatha, constituted by the Thysanoptera and Hemiptera. Lienhard notes that there are no Palaeozoic fossils which can actually be called Psocoptera (in agreement with this reviewer, see Mockford, 1993, pg. 2). The ordinal placement of the Permian fossils collectively called Permopsocida remains a puzzle. The monophyly of the Psocoptera, as separate from the Phthiraptera, is upheld on the basis of certain egg and embryonic characters (Seeger, 1979), but I feel that the question is still open. Lyal (1985) has given a carefully reasoned argument for the possible derivation of the Phthiraptera from the extant psocid family Liposcelididae. Ten pages are devoted to a very useful discussion of methods for collection, rearing, preservation, and study.

The main body of the text (361 pp.) is a systematic account of the psocids known from the region. This section begins with a diagnosis of the order, with the useful addition of means of recognizing forms that look like psocids but are not (aphids, psyllids, and coniopterygids). A key to the suborders follows, then keys to the families of the region in each suborder. The keys are well illustrated, but finding the scattered figures is time-consuming. Of great value is a separate key to the forms of Suborder Psocomorpha with wings reduced or absent. The accounts which follow the family keys are arranged under suborder, family group, family, genus, and species. Each suprageneric taxon is diagnosed, and following each family diagnosis is a key to the genera found in the region. Within each genus the type species and generic synonymy are noted. All genera except those monotypic in the study area are diagnosed: for each of the monotypic genera the diagnosis is that of the single included species plus the characters in the key. For each genus with more than one species in the study area there is a key to the species. For each species there is a complete synonymy, a diagnosis, and a paragraph on biology and distribution. The species diagnoses are adequate to identify each species recorded within the study area. The paragraph on biology and distribution indicates the habitat (live plants, dead plants, stones, domestic situations, etc.), mode of reproduction, and known geographic distribution within and outside the study area. Excellent illustrations are at hand for each diagnosis and generally are located within a page or two from each diagnosis. Line drawings are remarkably clear and each is of a size that can leave no doubt about the nature of the characters being portrayed. For the difficult genus *Liposcelis*, with 36 species in the study area, line drawings are supplemented with interference-contrast or phase-contrast photographs of the cuticular sculpture.

Following the systematics section is a 20-page account entitled "Faunistique", which will be of considerable use to students of biogeography. A graph of the cumulative number of species known through time indicates that our knowledge of the western Palaearctic psocids has grown in approximately the same pattern as that of world fauna. At 244 species (1998), the line rises vertically, so it is likely that any major collecting effort, especially in the southern periphery, will add species. Species known only from domestic habitats (households and stored foods) include all members of the families Lepidopsocidae (five species) and Psoquillidae (three species), plus five members of other families. *Cerobasis annulata* (Hagen) and *Trogium pulsatorium* (L.), known only from domestic habitats in North America, are common elements of the litter fauna in the Mediterranean region. In addition to these domestic species, some 30 species are widely distributed within and outside of the study area. Of the remaining fauna, certain assemblages of species are characteristic of sub-regions of the study area. A central European fauna of some 100 widely distributed species is recognizable. Northern Europe and the alpine areas show only impoverishment of this fauna, with no specialized northern species. Eastern Europe, lacking some of the central European species, has nine species absent or rare in the central region. The European Atlantic coasts and the British Isles contain several species not found in the rest of the study area. The Mediterranean Basin contains many species not found in the rest of the study area, including many of the *Liposcelis* species, and the only representatives of the largely tropical families Troctopsocidae, Amphientomidae, Pachytroctidae, Pseudocaeciliidae, and Myopsocidae. Within the Mediterranean Basin, distinctive eastern, western and North African subfaunas can be recognized, each with a number of endemic species. The Macaronesian Islands, i.e. the Canaries and Madeira, show a high level of endemism. Notable here are ten of the 14 species of the genus *Cerobasis* found in the study area. The faunistic section ends in a faunistic bibliography by country, in which, under the name of each country of the study area (some taken conservatively, such as "ex-USSR"), literature citations are entered for all publications containing records of psocids for the country. This material is summarized in a synoptic table listing all of the species known from the study area and indicating each country in which each species has been recorded.

A 40-page bibliography lists the literature cited through the year 1996. Included are nearly all publications that have dealt in any manner with psocids of the study area.

The bibliography is followed by two appendices and a table of contents. Appendix 1 is a comprehensive list of the abbreviations used in the book. Appendix 2 is an alphabetical index to all scientific names of Psocoptera mentioned in the book, including synonyms. The detailed table of contents (9 pp.) offers a checklist of all included taxa down to species level. The 52 domestic species are especially marked on this checklist as an aid to applied entomologists interested in psocids living in households and stored foods.

At the end are plates of photographs, including 1) the aspirator and beating apparatus (clear enough to allow construction), 2) a live specimen of *Liposcelis rufa* Broadhead in dehydrated and re-hydrated condition, 3–8) primarily species of *Liposcelis*—whole specimens and details of cuticular sculpture, 9–10) color photographs, primarily of adults, eggs, and larvae of an assortment of European

species, and 11) color photographs of spermathecae and spermatophores by differential-contrast microscopy.

The abundance and clarity of illustrations in this work make it of great potential value to investigators, even those without a precise knowledge of French. The 148 figures are each a composite of from three to 17 individual illustrations. Without undertaking the laborious task of counting the actual number of illustrations, I have made an estimate of 1,170 based on a mean derived from a count of 10 representative figures.

For as long as people study psocids, Lienhard's book will be an important reference, and for many years it will set a standard for systematic work on these insects. My only regret about this book is that it did not come out in hard cover. The heavy paper covers of my copy are starting to show some wear already.—*Edward L. Mockford, Department of Biological Sciences, Illinois State University, Normal, Illinois, 61790-4120.*

LITERATURE CITED

- Hennig, W. 1969. *Die Stammesgeschichte der Insekten*. Senckenberg-Buch 49. Frankfurt am Main, 436 pp.
- Hennig, W. 1981. *Insect Phylogeny*. Chichester. xxii + 514 pp.
- Lienhard, C. 1994. Hundert Jahre Insektensystematik am Beispiel der Psocopteren. *Revue suisse Zool.* 101:853–854.
- Lyal, C. H. C. 1985. Phylogeny and classification of the Psocodea with particular reference to the lice (Psocodea: Phthiraptera). *Syst. Ent.* 10:145–165.
- Mockford, E. L. 1993. North American Psocoptera. *Flora and Fauna Handbook 10*: Sandhill Crane Press, Gainesville, FL. xviii + 455 pp.
- Roesler, R. 1944. Die Gattungen der Copeognathen. *Stett. ent. Ztg.* 105:117–166.
- Seeger, W. 1979. Spezialmerkmale an Eihüllen und Embryonen von Psocoptera im Vergleich zu anderen Paraneoptera (Insecta); Psocoptera als monophyletische Gruppe. *Stuttg. Beitr. Naturk., Ser. A*; 329:1–57.
- Steyskal, G. C. 1973. Notes on the growth of taxonomic knowledge of the Psocoptera and on the grammar of the nomenclature of the order. *Proc. Ent. Soc. Wash.* 75:160–164.

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The Butterflies of Papua New Guinea: their systematics and biology.—Michael Parsons, Oct. 1998, Academic Press, San Diego. 736 pp. with 57 text figs., 26 inked and 136 color plates. ISBN 0-12-545555-0 \$275.00

This is a big (8" × 12"), expensive book that comprehensively describes and illustrates the 820 known species of butterflies living in the eastern half of the island of New Guinea. In tackling the butterfly fauna of this remote and poorly-known island, Parsons has undertaken a task never attempted before (except to a more limited extent by himself; Parsons, 1991). The result is not only a guide to the butterflies, but also a substantial book-within-a-book reminiscent of Vane-Wright and Ackery (1989) or Tyler et al. (1994), addressing broad-ranging aspects of biogeography, ecology, systematics and conservation in PNG.

The book is clearly organized and attractively produced, with two columns of text per page and the plates on semi-glazed heavy paper at the back. The contents are organized as follows: Chapter 1 is a brief overview and explanation of the organization of the species accounts (see below). The substance of the book begins with Ch. 2, a 15-page review of the tectonic history of New Guinea, its climate and vegetation. This is followed by a short chapter on global butterfly diversity, with comparisons of generic and specific endemism between New Guinea and surrounding land masses, and a longer chapter focussing on the origins of the New Guinea fauna per se. Parts of the latter are quite general (e. g., explanations for greater diversity in the tropics), and I would have included them in the former.

Chapter 5 is a fascinating history of the early exploration and who's who of subsequent butterfly collectors in PNG, with detailed vignettes about many individuals, including Alfred Stanley Meek, Lucy Evelyn Cheesman, and even the noted lepidopterist Ernst Mayr. One or two inconsistencies were noted, such as the statement on p. 44 that "(i)n 1873, the first British person to see NG was Captain Moresby, who landed on the southern coast of PNG," followed by the statements on p. 45 that "John MacGillivray was naturalist on the survey ship HMS Rattlesnake which visited NG in 1849–50," and that A. R. Wallace likewise visited and collected butterflies in New Guinea, in 1858.

Chapter 6 is a discussion of conservation and commercial issues with particular emphasis on farming and trading in *Ornithoptera* Boisd. specimens, a subject with which Parsons has had extensive experience (e. g., Parsons, 1992). Parsons stresses the importance of the legal insect trade for promoting habitat conservation, educating local people, and reducing the tendency for poaching. Chapter 7, entitled "Aspects of butterfly ecology in PNG," addresses ecological biogeography (issues of local and regional abundance and altitudinal diversity gradients), and life history (adult feeding and mating behavior, parasitism, and myrmecophily). The examples are drawn not only from NG butterflies, but also from taxa such as neotropical *Heliconius* Kluk. Chapter 8 begins with an introduction to the theory of mimicry, and then turns to a discussion of nine mimetic complexes present in PNG. Although there are a few references to illustrations of particular species, it is a pity that none of these complexes is illustrated in a comparative plate (e. g., Vane-Wright and Ackery, 1984, Plate 1c), particularly since several of the models are arctiid, uraniid or agaristine noctuid moths not illustrated in the book.

Chapters 9 and 10 briefly but accurately cover the introductory material on collecting and adult morphology traditional to most butterfly guides. Parsons emphasizes the importance of collecting immature stages in addition to adults, and gives a few useful tips on collecting techniques. There are sensible instructions for genitalia preparations, including the recommendation for preservation in glycerol-filled microvials instead of on slide mounts.

Chapter 11, addresses a variety of theoretical and practical problems in systematics from a somewhat eclectic perspective. For example, Parsons states that all taxa above the species level are "artificial groupings" (p. 117), advocates the occasional description of intrasubspecific forms (p. 119), and offers only two rather dated citations (Griffiths, 1974; Johnson and Quinter, 1982) discussing differences between cladistics, phenetics and evolutionary taxonomy. He discusses the problem of species and subspecies at some length, and evidently subscribes to Mayr's (1940) Biological

Species Concept (although this is never stated explicitly). The chapter's conclusion implies that the cladistic approach, underlain by extensive data and a thorough grounding in natural history, will provide the most robust classification, but that truth in such matters is inevitably elusive (both positions with which I concur).

Descriptions of taxa begin on p. 129, with a synopsis of the diversity, classification, characters and natural history of HesperIIDae. This is followed by similar breakdowns of subfamilies, genera species groups, and species in a standard hierarchical framework, which carries on to cover the other four butterfly families over the next 500 pages. Many useful references to the primary literature are provided, particularly in discussions of higher groups. Species descriptions include references to the holotype (including transcriptions of original labels), brief synonymy, subspecific names of taxa occurring in PNG, quite detailed information on range (or locality data, for rarely-collected taxa), descriptions of adults with reference to the plates and to distinguishing features from similar species, and life history data on immature stages, food plants and behavior, when known. Descriptions of well-studied taxa, such as *Ornithoptera* species, can extend over more than five pages and include distribution maps, although most accounts occupy less than one page.

There are eleven appendices. First is a one-page synonymic gazetteer of place names (too short, in my opinion). Second is an interesting chronological list of collecting localities for five historically important collectors. Third is a summary list of the 305 changes of taxonomic status Parsons has incorporated in the book (more on this topic below). Appendices IV–VIII are lists of genera and species endemic to various areas. Appendix IX is a list of names associated with *Atrophaneura polydorus* (L.), which Parsons evidently deemed too extensive to include in the body of the text. Appendix X is a list of PNG genera indicating recent revisionary efforts by various authors (among these are indicated Parsons' previously published and unpublished taxonomic work on more than 50 genera). Last is a checklist of the 959 species Parsons recognizes to occur on the entire island of New Guinea, with authors, dates and plate numbers for illustrated taxa. All taxonomic references are cited in the extensive bibliography section. There is a short glossary of miscellaneous technical terms, and two separate indices for subjects and taxa.

The plates fall into three groups: line drawings (I–XXVI), pinned adults (1–104), and life-history photographs (105–136). The line drawings are primarily of male terminalia, which include numerous holotype dissections. While generally well-executed, they are crowded, minimally labeled, and probably of limited use to most consumers of this book. The plates of adults are state-of-the-art D'Abrera-style color images of the left side of most species, illustrated from above and below and placed together in a composite mirror-image. They are clearly labelled, although there is only a general reference to the range of text pages covered by the entire plate, instead of a specific reference to the page where each illustrated species is presented. Plates 105–136 contain 380 photos of various eggs, larvae, pupae and adults on foodplants or in other natural surroundings. They are mostly of very good quality, although some are slightly out of focus. Many seem to have a color distortion that overemphasizes orange hues.

Several things were omitted from the book that I would have found useful. Foremost among these is a good map of the region. There are several schematic maps in the first part of the book illustrating tectonic history, areas of endemism and the

like, but these bear few place-names and are not useful for finding even such frequently-mentioned places as the Bulolo-Wau valley or the Sepik River. Further, it is not clear which museums Parsons has visited during the course of his work, where the specimens illustrated in the plates were collected, and where they are currently housed. The implication of this omission is that Parsons considers the specimens in the plates to be "typical" of their species, a notion at odds with his Mayrian species concept.

A trend I would like to see curtailed (Brower 1996, 1998) is the formal revision of taxonomic nomenclature outside the peer-reviewed periodical literature by what might be referred to as authoritative realists (i. e., authors who feel confident to publish ontological assertions about the taxa they study without making manifest the empirical evidence upon which their claims are based). Although I harbor no doubts about Parsons' taxonomic acumen, it makes me very uncomfortable to see incorporated into this book more than 300 taxonomic changes, distributed among 67 genera across all families. Many of the changes presented are unaccompanied by any discussion or lists of material examined. For example, seven names placed in *Euploea* F. are synonymized under *Euploea stephensii* (C. & R. Felder) within nine lines of text that indicate only the sex and locality data of holotype specimens. A note at the end of the species account states, "In view of the variability and polymorphism of *stephensii*, the synonymy established above is necessary to clarify its phenotypic diversity in PNG." Given that those names survived Ackery and Vane-Wright's comprehensive cladistic revision of the tribe Danaini (1984), the decision to synonymize them in a book whose scope is much broader and necessarily more diffuse than a revisionary monograph's seems perfunctory.

In conclusion, I would like to point out that all my book reviews are critical: I don't believe in churning out flattering creampuffs to keep myself on the publishers' mailing lists for complementary review copies. However, the particular criticisms enunciated here should by no means be construed to imply that *The Butterflies of Papua New Guinea* is not generally excellent. I believe that Parsons' book will provide museum curators and butterfly enthusiasts alike with a common touchstone for classification and communication for many years to come. The text is well-organized, the coverage comprehensively reflects the state of our current knowledge, and the color plates are superb.—Andrew V. Z. Brower, Dept. of Entomology, Oregon State University, Corvallis OR.

LITERATURE CITED

- Ackery, P. R. and R. I. Vane-Wright. 1984. *Milkweed butterflies*. British Museum (Natural History), London. 425 pp.
- Brower, A. V. Z. 1996. Book review of "The Butterflies of Venezuela, Part 1: Nymphalidae I (Limenitidinae, Apaturinae, Charaxinae). J. New York Ent. Soc. 104:236–239.
- Brower, A. V. Z. 1998. A fair book review? A reply to Mr. Willmott. New Lepid Soc. 40:106.
- Griffiths, G. C. D. 1974. Some fundamental problems in biological classification. Syst. Zool. 22:338–343.
- Johnson, K. and E. L. Quinter. 1983. Commentary on Miller and Brown vs. Ehrlich and Murphy et al.: pluralism and the worldwide nature of kinship groups. J. Res. Lepid. 21:255–269.
- Mayr, E. 1940. Speciation phenomena in birds. Amer. Nat. 74:249–278.

- Parsons, M. J. 1991. Butterflies of the Bulolo-Wau Valley. Handbk. Wau Ecol. Inst. No. 12: 228 pp., 25 plates, 23 Figs.
- Parsons, M. J. 1992. Butterfly farming and conservation in the Indo-Australian Region. *Trop Lepid.* 3 (Suppl. 1):1–62.
- Tyler, H. A., K. S. Brown Jr. and K. H. Wilson. 1994. Swallowtail butterflies of the Americas. Scientific Publishers, Gainesville, FL. 376 pp.
- Vane-Wright, R. I. and P. R. Ackery (eds.). 1989. *The biology of butterflies*. Princeton, NJ, Princeton University Press. 429 pp.

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Hémiptères Lygaeidae Euro-Méditerranéens. Faune de France.—J. Péricart, 1998. France et Régions Limitrophes 84a. Fédération Française des Sociétés de Sciences Naturelles. 57, rue Cuvier, B. P. E.-75232 Paris. (Cedex 05.) 3 Volumes, (paged separately, each over 400 pages). Price 3 volumes 1,400 French francs (=Euro 213,40) + postage.

It is impossible to overemphasize the importance, scope and overall quality of this work. It will certainly remain the standard reference work on the Lygaeidae (sensu latu) of the western Palearctic, including the Near East and the Mediterranean, for many years to come.

Although part of the series of the Fauna of France, the coverage is much more extensive for, in addition to the broad area covered, numerous species whose main distributions are tropical and subtropical Asiatic and African are included.

One can say without hesitation that this extensive three-volume work exemplifies what a faunal study should be. Dr. Péricart, in addition to his own extensive knowledge, has been able to draw upon the voluminous faunistic and biological knowledge that generations of European students, both professional and amateur, have built up over the years. Such detailed information on the distribution, ecological associations and taxonomic relationships of each species can only evoke both admiration and envy when compared with our knowledge of the fauna of any other area of the world, including the Nearctic.

This work is much more than just a fine faunal study. There are many added features, chief among them being the beautiful dorsal view drawings, most by Dr. Péricart himself. These are so finely done that there is the constant feeling that one is actually looking at the insect under the microscope. There are approximately 147 detailed dorsal-view drawings of adults, 59 outline sketches, and 72 detailed dorsal views of the nymphs (larvae), with 28 additional outlines. To give some idea of the scope and number of illustrations the last set of figures in volume three is entitled "Figure 401" but this gives no real idea of the immense number of illustrations actually present. As an example in one modest-sized tribe, the Megalonotini, in addition to the 45 dorsal view illustrations, there are 16 maps, 67 paramere sketches, 29 of the fore femora, 26 genital capsules, 12 scent gland sclerite positions, 11 spermathecae, 5 sperm reservoirs, 5 fore tibiae, 4 eggs, 4 antennae, 3 phalli, 2

pronota, 2 heads, and 2 lateral and ventral body views. This is a total of 245 figures for a taxon of 17 genera and 52 species.

The text within each taxon includes a description based on the adults, and usually one of the nymphs also, with keys to genera and species including those of known nymphs. This latter feature is of special interest as it incorporates the extensive study of V. G. Putshkov which was originally published in Ukranian.

The first volume includes an extensive historical review, a discussion of adult morphology (with 57 figures), the eggs (32 figures), nymphs (14 figures) and a general discussion of the general ecology and ethology, including a discussion of wing polymorphism, myrmecomorphy and myrmecophily and a summary of the zoogeographic background of the fauna. This volume also contains keys to subfamilies of adults and nymphs and begins the formal treatment of each taxon.

The work concludes with a 71-page bibliography, and an index of plants as well as of the insects themselves. A nice feature is a quick separate index to genera only.

Dr. Péricart treats the Lygaeidae in the traditional sense as it was recognized prior to Henry's 1997 cladistic reorganization. The latter work is discussed in an addendum in volume three where the author feels it premature to adopt so many extensive changes in a study of this type (correctly in this reviewers opinion) until the new classification advocated has been tested over a period of time.

In addition to the formal text, there are 34 color photographs of excellent quality showing live insects in their habitats. Each volume is dedicated to a leading European hemipterist: Volume I to Jacques Carayon (Péricart's mentor); Volume II to Vassili G. Putshkov, and Volume III to Gustav Seidenstücker.

Each volume is produced on high quality paper with clear and clean text and each has a color cover photograph of a live insect in situ.

With such an outstanding work there is little to object to. I do think that the retention of a key format that separates the two halves of a couplet, sometimes by a considerable distance, is holding onto a tradition long after it has become obvious that it is unwieldy and probably really is an attempt to show relationships in a key at the sacrifice of ease of use. Dr. Péricart's treatment of wing polymorphism is disappointing, possibly because of my feeling that the Lygaeidae are a key group for any such study. He feels no adequate classification of the types of wing modifications exists and does not relate wing reduction strongly to habitat stability. His statement that the extralimital genus *Poeantius* Stål is a true myrmecophile is certainly incorrect and presumably based on an early statement in a paper by Bergroth and Poppius who never examined these myrmecomorphic insects in the field. The reader should be aware that occasionally a figure for one subfamily is inserted on the plate for another. But these are minor problems when viewed against the scope and quality of the work. It is a must for the shelf of every serious heteropterist and of value to anyone interested in a large and diverse group of terrestrial Palearctic organisms.—James A. Slater, University of Connecticut, Storrs, Ct. U.S.A.

INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

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